U.S. DEPARTMENT OF ENERGY
OFFICE OF NATURAL GAS AND PETROLEUM TECHNOLOGY

OIL AND GAS ENVIRONMENTAL PROGRAM RETROACTIVE METRICS FOR 1996 TO 2000 WITH PROJECTIONS TO 2005

ANALYSIS AND RESULTS

- DRAFT REPORT -

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EXECUTIVE SUMMARY

The mission of Oil and Gas Environmental Program of the U.S. Department of Energy (DOE) Office of Natural Gas and Petroleum Technology (ONGPT) is to enhance the production of domestic oil and gas while minimizing environmental impacts associated with the recovery of these resources. To achieve these goals, ONGPT's Oil and Gas Environmental Program advocates informed, risk-based environmental regulation. The ONGPT Environmental Program provides technical support for risk-based decision-making, as well as the development of best practices and guidelines that contribute to informed environmental regulation. The Office of Natural Gas and Petroleum Technology previously developed comprehensive measures or "metrics" that estimate the expected future contribution of Oil and Gas Environmental Program activities to such national goals as economic strength, environmental protection, and energy security. Specifically, the environmental metrics analyses estimate the compliance cost savings expected from Oil and Gas Environmental Program activities in the areas of risk assessment, regulatory advocacy, and technology development. These cost savings are used to forecast the economic and energy resources which, in the absence of the ONGPT Environmental Program, might otherwise be lost due to rising environmental compliance costs. Results of the 1996, 1998, and 2000 environmental program metrics analyses predict significant public benefits from ONGPT Environmental Program activities. Future compliance cost savings translate to increased domestic oil and natural gas production because lower well costs extend the profitable operating life of oil or natural gas wells. In turn the incremental increase in oil and natural gas production impacts broader economic measures such as industry revenues, Federal and state revenues and royalties, and direct and indirect employment.

The purpose of a retroactive analysis of the Oil and Gas Environmental Program is to provide a "look back" at actual Environmental Program activities to estimate the *actual past and current impact* of the ONGPT Oil and Gas Environmental Program. The retroactive Environmental Program metrics analysis is intended to complement the previous forward-looking metrics analyses. The underlying technical approach for the retroactive metrics corresponds to the technical approach of previous forward environmental metrics. The results of the retroactive metrics analysis may be compared to earlier forward environmental metrics analyses to determine how well previous metrics analyses predicted future environmental compliance requirements and ONGPT Environmental Program outcomes. One objective of the retroactive environmental metrics analysis is to estimate the past and current impact of ONGPT Environmental Program activities during 1996 to 2000. An additional objective is to estimate the future impact of current program activities for the years 2000 to 2005, up to the start of the 2000 forward environmental metrics analysis.

Model results from the retroactive metrics analysis indicate that during 1996 to 2000, ONGPT Environmental Program activities contributed an estimated 100 million barrels of incremental oil and 600 billion cubic feet of incremental natural gas that otherwise might not have been produced. During the same period, the ONGPT Environmental Program is estimated to have provided more than $5.4 billion in environmental compliance cost savings and more than $1 billion in total government revenue. Environmental Program activities are estimated to have contributed almost 8,000 labor-years of direct industry employment, or approximately 1,600 industry jobs. During the ten-year period from 1996 to 2005, the Environmental Program is expected to contribute almost 329 million barrels of oil and almost 1.9 trillion cubic feet of natural gas. During the same period the ONGPT Environmental Program is estimated to provide more than $9.7 billion in environmental compliance cost savings and $4.3 billion in total government revenue. From 1996 to 2005, Environmental Program activities are estimated to contribute more than 27,000 labor-years of direct industry employment, or approximately 2,700 industry jobs.

1. INTRODUCTION

1.1 Background and Objectives

During the period 1996 to 2000, the U.S. Department of Energy Office of Natural Gas and Petroleum Technology (ONGPT) conducted three metrics analyses of the Oil and Gas Environmental Program. The purpose of these metrics analyses were to quantify the future public benefits expected from ONGPT activities in the areas of environmental regulatory advocacy, environmental risk assessment, environmental compliance technology development, and technology transfer. In each of the Environmental Program metrics analyses developed for 1996, 1998, and 2000, ONGPT forecasts the expected future impact of program activities directed at supporting domestic oil and natural gas production while promoting an effective level of environmental protection. These forward-looking environmental metrics analyses estimate the future impact or "benefit" of the ONGPT Environmental Program in terms of potential impact on U.S. oil and natural gas production, adjusted industry revenues, Federal and state revenues and royalties, employment, and environmental compliance cost savings.

The Office of Natural Gas and Petroleum Technology, in conjunction with the National Petroleum Technology Office, recently completed a retroactive environmental metrics analysis for the period 1996 to 2000. The purpose of the retroactive environmental metrics analysis is to estimate the past and current impact of the Oil and Gas Environmental Program, and determine whether Environmental Program activities were as effective as predicted by the earlier metrics analyses. This report documents the technical approach, assumptions, and results of the first ONGPT Environmental Program retroactive metrics analysis conducted during March through August 2000. The objectives of the retroactive environmental metrics analysis are the following:

- Estimate the past impact of ONGPT Environmental Program activities for the years 1996 to 2000.

- Estimate the current and near-term impact of ONGPT Environmental Program activities for the years 2000 to 2005, to capture Environmental Program benefits up to the point at which the 2000 forward environmental metrics analysis begins.

This report provides a brief review of the technical approach of the forward environmental metrics analyses followed by a more detailed discussion of the technical approach developed for the retroactive metrics analysis. The combined oil and gas analytical model results for the retroactive metrics are presented and compared to corresponding results from the 1996, 1998, and 2000 forward environmental metrics. Appendix A provides the separate oil model and gas model retroactive metrics results. Appendix B contains documentation of the unit costs, analytical model cases, and supporting information for each of the environmental compliance issues included in the retroactive metrics analysis.

1.2 Overview of Forward Environmental Metrics Analysis

The 1996 Environmental Program metrics analysis was originally developed in response to the Government Performance and Results Act of 1993 (GPRA) which requires U.S. federal agency programs to provide a comprehensive assessment of budget priorities and to quantify specific program contributions to national strategic goals. In response to GPRA, DOE's Office of Natural Gas and Petroleum Technology compiled a set of measures, or "metrics," to describe and quantify direct benefits expected to result from program activities in the areas of regulatory advocacy, risk assessment, environmental technology development and technology transfer. The various metrics used to measure program contribution provide regulators and policy-makers with critical information for planning, developing and sustaining oil and gas environmental requirements that will maximize public benefits.

The basic analytical approach for the ONGPT Environmental Program metrics was developed for the 1996 metrics analysis and subsequently updated for the 1998 analysis. The technical approach of the 2000 metrics analysis was further enhanced to provide a more realistic assignment of estimated environmental compliance costs to individual reservoirs. The technical approach of the 1996 environmental metrics analysis and the subsequent enhancements for the 1998 and 2000 environmental metrics are documented in three technical reports previously prepared for the Office of Natural Gas and Petroleum Technology:

- *DOE Oil and Gas Environmental Program Metrics 1996 Analysis and Results*, June 1997.
- *DOE Oil and Gas Environmental Program Metrics 1998 Analysis and Results*, February 1999, prepared for ONGPT under DOE Contract No. DE-AC01-95FE62467, Task 3
- *DOE Oil and Gas Environmental Program Metrics 2000 Analysis and Results*, August 2000, prepared for ONGPT under DOE Contract No. DE-AC01-95FE62467, Task 12

The unit environmental costs developed for the previous environmental metrics analyses are used in the retroactive metrics analysis. The detailed environmental cost analyses for individual environmental compliance issues are documented in the reports listed above. Consequently, the detailed cost calculations and supporting documentation are not reproduced in this report but may be found in each of the three previous environmental metrics reports.

The mission of the Office of Natural Gas and Petroleum Technology Environmental Program is to support the production of domestic oil and gas while minimizing environmental impacts associated with the recovery of these resources. The two primary components of the ONGPT Environmental Program are:

- Regulatory advocacy and risk assessment designed to encourage more informed, risk-based outcomes in future regulatory development, and
- Research and development of new technologies and practices that reduce the costs associated with environmental compliance efforts.

Both components of the Oil and Gas Environmental Program provide direct benefits in the form of compliance cost savings. By informing the regulatory process through advocacy and risk assessment efforts, the Environmental Program contributes to the development of cost-effective regulations that protect the environment and minimize unnecessary regulatory burdens on the domestic oil and gas exploration and production industry. The Department of Energy's research and assessment of environmental technologies contribute to the development of lower cost, environmental compliance strategies which meet regulatory compliance obligations and allow for the greatest possible resource recovery. New technologies that provide lower cost compliance strategies allow oil and gas producers to achieve a level of environmental protection at a lower cost. In turn, lower compliance costs extend the economic operating life of oil and gas wells and increase the ultimate recovery of crude oil and natural gas. Through the Oil and Gas Environmental Program, DOE facilitates the development and transfer of new compliance technologies and practices, which together support cost effective regulatory compliance and increased domestic production.

Tangible program benefits accrue to oil and gas producers from environmental compliance cost savings that result from ONGPT Environmental Program activities. The expected cost savings from regulatory advocacy, risk assessment, and technology development activities also impact broader economic and energy metrics such as crude oil and natural gas production, government revenues and royalties, industry revenue, and direct and indirect employment. The benefits associated with ONGPT's Oil and Gas

Environmental Program are calculated using an "expected value" approach. This probabilistic approach estimates unit compliance costs expected from environmental requirements that may be imposed upon the oil and gas industry in the future. Future environmental program benefits are estimated based upon the probability that program activities will either minimize unnecessary loss of domestic production and reserves due to overly stringent environmental regulation, or will support new technologies that reduce environmental compliance costs associated with potential regulatory requirements.

The impact of the ONGPT Environmental Program on expected compliance costs is determined by calculating the difference in the expected compliance costs for three different cases:

- Industry plus DOE Case ("With DOE"),
- Industry Only Case ("Without DOE")
- Stringent Case

The Industry Only case represents the impact of potential future environmental requirements in the absence of DOE regulatory advocacy and technology development activities. The Industry plus DOE case accounts for contributions from ONGPT Environmental Program activities. For regulatory issues, the Stringent case represents the most stringent environmental compliance alternative; for technology issues the Stringent case represents a case of limited technology research and development by both government and industry.

For the forward environmental metrics analysis, environmental issues affecting oil and gas exploration and production are identified and grouped into a number of categories:

- Drilling
- Produced Water Management
- Production Waste Management
- Remediation
- Air Emissions
- Underground Injection
- Spills and Releases
- Regulatory Streamlining.

One or more future environmental compliance scenarios are developed for each issue based upon expectations for future environmental compliance requirements, or new and emerging environmental technology. The scenarios represent a reasonable range in either the potential stringency of future regulatory requirements or the potential application of future technology. An average "per well" environmental compliance cost or cost savings is estimated for each scenario, as well as a corresponding probability of occurrence and expected year of implementation. Different probabilities (and, in some cases, different compliance costs) are assigned to the Industry Only (Without DOE), Industry plus DOE (With DOE), and Stringent cases for each scenario. The different probabilities of occurrence for the With DOE, Without DOE, and Stringent cases capture the expected contribution of the ONGPT Environmental Program to the future outcome of the scenario.

The incremental environmental compliance costs estimated for the With DOE (Industry plus DOE), Without DOE (Industry Only), and Stringent cases are supplied to DOE's integrated oil and gas system models, the Oil System Analysis Model (OSAM) and Gas System Analysis Model (GSAM).

Environmental compliance costs are supplied to the models as capital costs (environmental investments) or as annual compliance costs (operating costs). The incremental compliance costs are further categorized as costs applied to new or existing, oil or gas, and onshore or offshore wells. As illustrated in Figure 1 and Figure 2, the With DOE, Without DOE, and Stringent cases are differentiated by the magnitude of the projected environmental compliance costs associated with each case. The difference in incremental environmental compliance costs between the With DOE and Industry Only cases represents the benefit (cost savings) of the ONGPT Oil and Gas Environmental Program. The environmental compliance cost savings in turn determines the impact of the ONGPT Environmental Program on broader energy and economic measures such as annual and cumulative production, private and public sector revenues, and environmental investments and operating costs.

Figure 1 shows that for regulatory compliance issues, the environmental compliance costs expected for the With DOE case are less than the expected environmental compliance costs for the Without DOE case. The Stringent case has the greatest projected environmental compliance costs. The difference between the With DOE case and the Without DOE case represents positive incremental costs. Figure 2 shows that for compliance technology research and development issues, the difference between the With DOE case and Without DOE case represents a compliance cost decrement, or reduction in environmental compliance costs due to future compliance technology research and development. Consequently, the difference between the With and Without DOE cases is represented as negative incremental costs for compliance technology issues.

Figure 1. Forward Environmental Metrics; Regulatory Issues

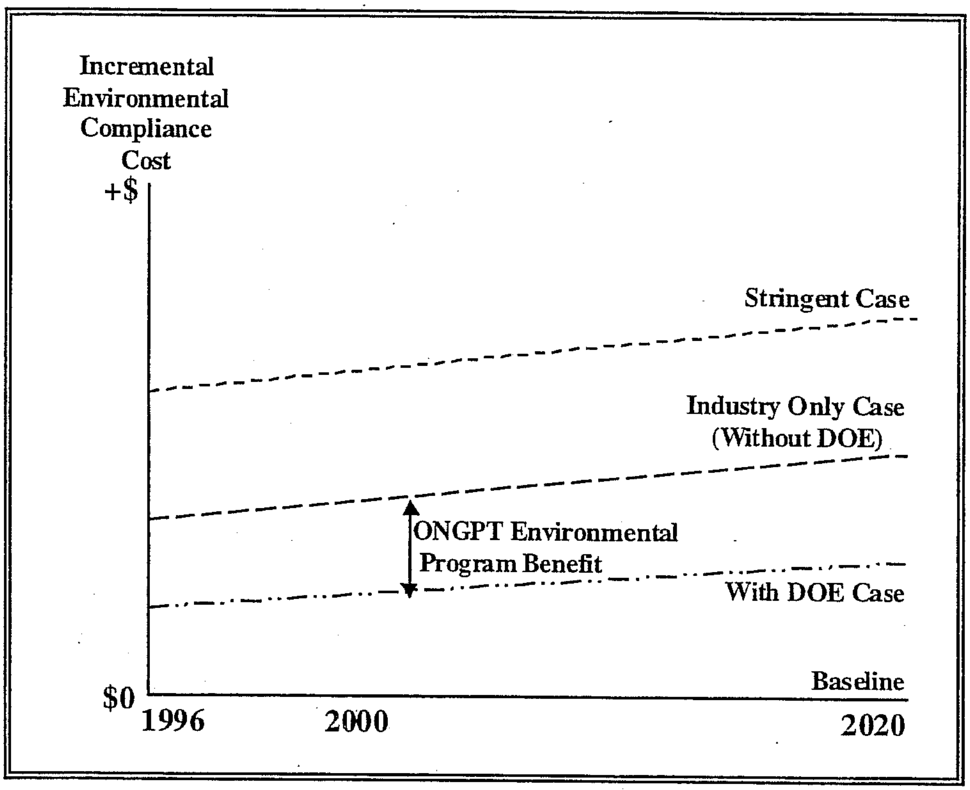
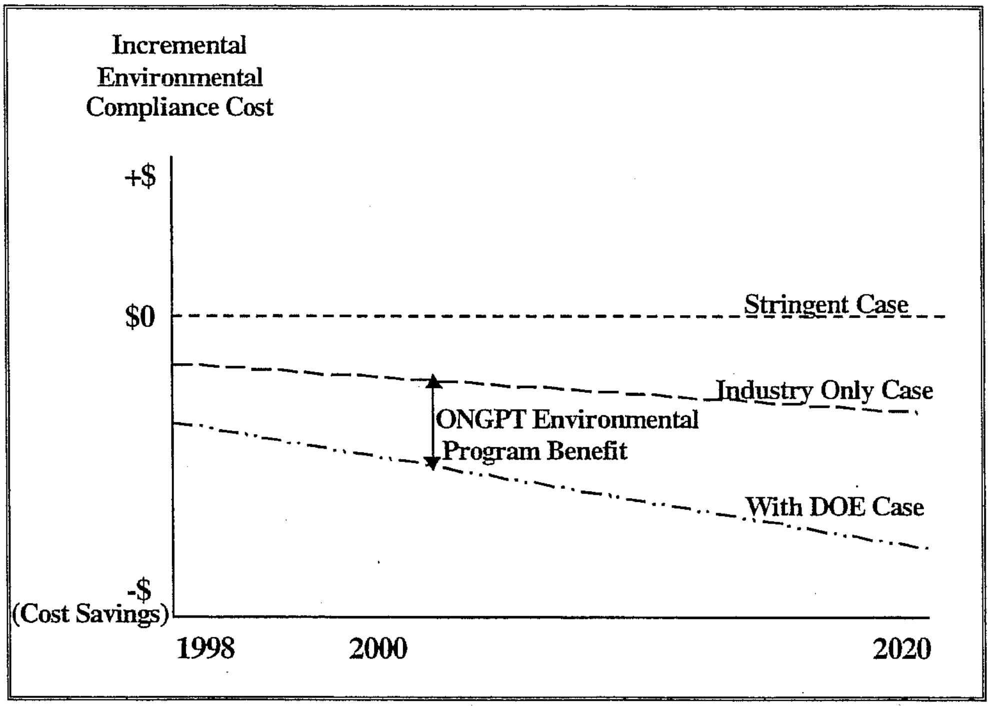


Figure 2. Forward Environmental Metrics; Environmental Compliance Technology Issues



2. Retroactive Environmental Metrics Technical Approach

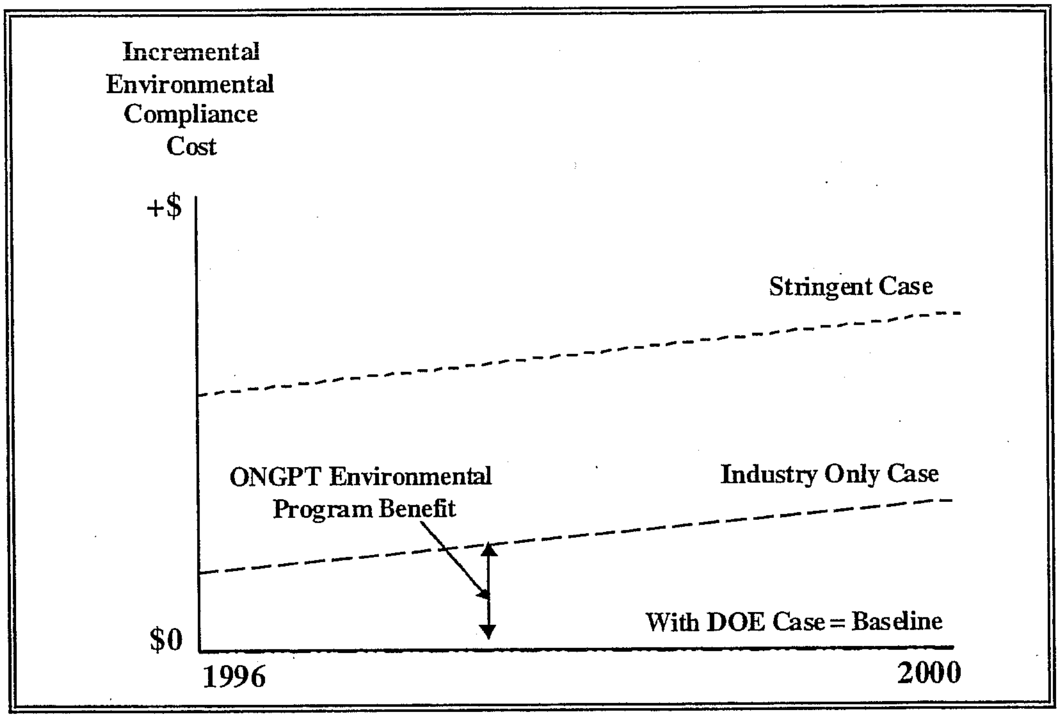
2.1. Overview of Technical Approach

The technical approach used for the 1996 to 2000 retroactive Environmental Program metrics analysis is based upon the approach developed for the previous forward Environmental Program metrics analyses. The retroactive metrics analysis evaluates actual ONGPT Environmental Program involvement for each environmental compliance issue considered in the 1996, 1998, and 2000 metrics analyses. Reservoir-level incremental environmental compliance costs are developed for three cases: a With DOE case, an Industry Only case, and a Stringent case. The benefit or impact of the ONGPT Environmental Program is expressed as the difference between the With DOE case and the Industry Only case. Following is an overview of the technical approach for the Environmental Program retroactive metrics analysis:

- Identify past and current environmental compliance issues that had direct impact or potential impact on oil and gas exploration and production activities.
- Determine the current or baseline scenario for each issue, 'what actually happened.' Develop a stringent or "worst case" scenario for each issue that represents the most stringent feasible outcome of pending and proposed environmental requirements for the period 1996 to the present.
- For each issue, develop an "industry only" scenario that represents the environmental requirements or compliance outcome that might have occurred in the absence of the ONGPT Environmental Program.
- For each environmental issue considered, estimate the incremental unit compliance costs and applicable years, or timing, which represent the baseline, stringent, and industry only scenarios.
- Provide the unit compliance costs and applicable years to the Oil and Gas Environmental Cost Model. The Oil and Gas Environmental Cost Model calculates incremental compliance costs for each environmental issue for each model case: With DOE, Industry Only, and Stringent, and applies the incremental costs for each environmental issue to individual reservoirs.
- From the environmental cost model, generate reservoir-level incremental environmental cost files for each model case. Input the incremental environmental costs to the Oil and Gas System Analysis Models, OSAM and GSAM.
- Obtain OSAM and GSAM results for each model case: With DOE, Industry Only, and Stringent. The difference between the model outcome for the Industry Only case and the model outcome for the With DOE case represents the total impact of the ONGPT Oil and Gas Environmental Program.

Figure 3 is a schematic illustration of the retroactive environmental metrics concept. The baseline case represents actual environmental requirements for the period 1996 through 2000. Environmental compliance costs for the baseline case are assumed to be actual average industry environmental compliance costs. Incremental environmental compliance costs are zero for the baseline case. By definition, the With DOE case for the retroactive environmental metrics analysis is also the baseline case, so the incremental environmental compliance costs for the With DOE case are also zero. The Stringent case is represented by positive incremental environmental compliance costs, and the Industry Only case is estimated to represent an outcome between baseline and the Stringent case requirements. As with the forward environmental metrics analyses, the impact of the ONGPT Environmental Program is represented as the difference between the With DOE case and the Industry Only case. The following sections of this report will discuss various elements of the retroactive metrics concept and technical approach in more detail.

Figure 3. Retroactive Environmental Metrics



2.2. Retroactive Environmental Metrics Model Cases

Three analytical cases are modeled for the retroactive metrics analysis. The retroactive metrics cases correspond in concept and name to the model cases developed for the 1996, 1998, and 2000 Environmental Program metrics analyses. This allows comparison between the retroactive metrics model results and the previous forward environmental metrics analyses.

Industry plus DOE Case (With DOE Case). The Industry plus DOE, or With DOE case, accounts for the impact of the ONGPT Oil and Gas Environmental Program, as well as the oil and gas exploration and production industry's environmental compliance research and development, and industry-led regulatory advocacy efforts. Because the retroactive environmental metrics analysis represents a "look backwards" on the period 1996 to 2000, the With DOE case must represent the current scenario for the period - actual environmental compliance costs with existing technology. By definition the environmental compliance costs for the With DOE case are represented by actual baseline compliance costs, so incremental environmental compliance costs for the With DOE case are zero. Appendix B contains unit cost summary sheets for each environmental issue included in the retroactive metrics analysis. The baseline scenario representing the With DOE case for each issue is described on the individual summary sheets in Appendix B. The estimated incremental compliance costs for all the baseline scenarios in Appendix B are zero because the baseline or With DOE case represents actual current and past compliance costs.

The baseline environmental cost files supplied to the Oil and Gas System Analysis Models (OSAM and GSAM) were reviewed and updated for the retroactive metrics analysis. The baseline environmental compliance costs used for the 1996 environmental metrics analysis were used as a starting point. A new set of baseline environmental costs was developed for each year of the retroactive environmental metrics analysis, 1996 to 2000. The new baseline environmental compliance cost files, which comprise the With DOE case, incorporate new environmental compliance cost data available since 1996. Sources of data used to update the baseline environmental compliance costs are listed at the end of this report. The retroactive metrics analysis was also projected forward to 2005 to capture the near term impact of current Environmental Program activities up to the point at which the 2000 forward environmental metrics commences. The environmental compliance costs for the With DOE case (baseline) for the period 2001 to 2005 were estimated by increasing the 2000 baseline environmental compliance costs by 3 percent annually.

Stringent Case. For regulatory issues, the Stringent case represents the most stringent *feasible* outcome of proposed and pending regulatory requirements during the period 1996 to 2005. The Stringent case is not intended to be the "worst case" imaginable. Instead, the Stringent case represents the incremental environmental compliance costs that were expected to result from the most stringent environmental requirements or alternatives that were proposed or pending during the 1996 to 2000. The Stringent case provides a feasible upper boundary to the retroactive metrics analysis and illustrates "what was at stake" in previous efforts to balance regulatory compliance costs and environmental benefits. The difference between the Industry plus DOE case (With DOE case) and the Stringent case indicates the costs to industry, the economy, and the public sector which could be imposed by needlessly stringent environmental compliance requirements.

For environmental compliance technology issues, the Stringent case represents limited technology research and development and a lower level of technology transfer and technology penetration. For technology issues, the higher compliance costs of the Stringent case represent the level that environmental compliance costs might have reached without government and industry efforts to develop cost-effective compliance technology.

Appendix B contains summary sheets for each environmental issue included in the retroactive metrics analysis. Each summary sheet describes the Stringent scenario and lists the corresponding estimated environmental compliance cost. The unit compliance costs for the retroactive metrics Stringent case were compiled from the Stringent scenarios developed for the environmental compliance issues included in the

1996, 1998 and 2000 metrics analyses. For example, "Offshore Drilling Waste Management" is an environmental compliance issue that is included in each of the forward environmental metrics analyses, as well as the retroactive metrics analysis (Appendix B, issue 3). The Stringent regulatory scenario for this issue is the potential future imposition of a zero-discharge effluent limitation for Cook Inlet, Alaska and the Gulf of Mexico Federal offshore areas. The incremental unit cost to comply with future limitations on offshore discharge of drilling wastes is estimated to be more than \$600,000 per new well in the Gulf of Mexico and more than \$1 million per new well in Cook Inlet. For the retroactive metrics analysis, the Stringent scenario for Offshore Drilling Waste Management remains the zero-discharge scenario; the estimated stringent compliance costs avoided by industry plus DOE Environmental Program activities are \$600,000 per new well in the Gulf of Mexico and \$1 million per new well in Cook Inlet, Alaska.

Industry Only Case (Without DOE Case). The Industry Only case represents the incremental environmental cost outcome that might have occurred without the participation of the DOE Oil and Gas Environmental Program. For each environmental issue, an incremental compliance cost for the Industry Only scenario is calculated by estimating the past level of DOE Environmental Program activities, and representing the effectiveness of program activities by a program "impact factor" ranging from 0.05 to 1.00. The incremental compliance cost for the Stringent scenario is then multiplied by the DOE Environmental Program impact factor to estimate an incremental environmental compliance cost for the Industry Only scenario. The DOE Environmental Program impact factor establishes the likely incremental cost of environmental compliance in the absence of DOE regulatory advocacy or technology development activities. For example, the Environmental Program impact factor estimated for the retroactive metrics issue, "Offshore Waste Management" (Appendix B, Issue 3) is 0.50. Using the program impact factor, the Industry Only incremental environmental compliance cost for the Offshore Waste Management Issue is estimated as follows:

<u>Industry Only Incremental Cost</u> = (Stringent Case Incremental Cost – With DOE Incremental Cost) x (Estimated Program Impact Factor)

= (\$600,000/new Gulf of Mexico well – \$0/new offshore well) x (0.50)

= \$300,000/new well

The Industry Only case represents the estimated level of regulatory advocacy and compliance technology research and development that the oil and gas industry could support in the absence of DOE. The Industry Only scenario is not explicitly described for each environmental issue in Appendix B. Instead, relevant ONGPT Environmental Program activities are listed for each issue and a program impact factor is shown. For the retroactive environmental metrics analysis, the incremental compliance costs for the Industry Only scenarios are calculated by the Oil and Gas Environmental Cost Model using the Stringent scenario incremental costs, the With DOE compliance costs (baseline costs) and the program impact factors for each issue. The Oil and Gas Environmental Program impact factors were determined for each issue by consensus of the members of the Office of Natural Gas and Petroleum Technology and National Petroleum Technology Office Environmental Teams. The program impact factors that are selected for each issue represent hours of discussion and review of past ONGPT/NPTO Environmental Program activities and program effectiveness. The ranking of types of Environmental Program activities shown in Table 2-1 was developed as starting point and guide for the Environmental Team's review of past program activities.

Table 2-1. Oil and Gas Environmental Program Impact Factors

Regulatory Issues	Estimated Environmental Program Impact Factor
Passive comments on rulemaking. Written comments.	0.05 - 0.15
Active comments on rulemaking. Fund analysis that provides basis for comments.	0.15 – 0.25
Facilitate dialogue between Industry and Government.	0.10 - 0.25
Collect data on industry practices. Help establish baseline practices for rulemaking process.	0.20 - 0.30
Active data collection for rulemaking process that involves new research.	0.30 - 0.50
Substantial involvement throughout the rule-making process from initial facilitation of stakeholder dialog and data collection through risk-based regulatory analysis to development of guidance documents and compliance workshops for stakeholders.	0.50 - 0.75
Technology	**Estimated Environmental Program Impact Factor**
Provide some project funding with resulting "report on shelf."	0.05 - 0.15
Fund cooperative research agreements such us Petroleum Environmental Research Forum.	0.15 – 0.25
Fund initial project development stage: concept tests, seed money, pilot projects, etc. Others entities develop the emerging technology to the stage of commercial application.	0.25 – 0.50
Fund research at various points in the R&D process and at various levels of funding.	0.25 – 0.50
The most comprehensive package of technology development from initial design through commercialization of the technology. Fund initial risk assessment and modeling of potential regulatory and economic impacts, pay for most R&D and technology transfer. Example: NORM, salt caverns disposal, DOWS	0.50–0.75

2.3. Retroactive Environmental Metrics, Environmental Compliance Issues

The retroactive environmental metrics analysis incorporates thirty-one environmental compliance issues shown in Table 2-2. Table 2-2 also lists all of the environmental issues included in each of the previous forward environmental metrics analyses. Although all of the issues included in the retroactive metrics analysis are included in at least one of the previous forward environmental metrics analyses, not all of the environmental issues included in the forward environmental program metrics analyses are included in the retroactive metrics analysis. Some environmental compliance technology issues, such as *produced water volume reduction* (downhole oil/water separation) and *drilling waste reduction by advanced drilling technology* (slimhole drilling, horizontal drilling), are omitted from the retroactive metrics because they represent new or emerging technologies. Despite little or no prior Environmental Program involvement with a new compliance technology, the forward environmental metrics analyses may nevertheless project *future* environmental program impact on emerging technologies. Similarly, some regulatory compliance issues, such *as reduction of regional haze, greenhouse gas emission reduction, and remediation of mercury contamination* are omitted from the retroactive environmental program metrics analysis. Although *future* Environmental Program impact on these compliance issues are projected by at least one of the forward environmental metrics analyses, current Environmental Program involvement with the issue is just emerging, or did not develop as expected in the past.

The Environmental Program retroactive metrics analysis evaluates ONGPT Environmental Program activities and impacts for thirty-one individual environmental issues in eight environmental issue categories shown in Table 2-2. Appendix B contains a summary or "unit cost" data sheet for each environmental issue within each environmental category. The unit cost data sheets summarize the critical components of the environmental cost calculation for each environmental issue. Each unit cost data sheet summarizes the stringent and baseline (With DOE) scenarios that were determined for each issue, as well as the unit incremental compliance cost representing the stringent scenario. Each unit cost data sheet contains an estimated ONGPT Environmental Program impact factor and the estimated years of past, current, or near term Environmental Program impact on the issues. The stringent scenario for each environmental issue in the retroactive metrics analysis is the same as the stringent scenario for the corresponding environmental issue in the forward environmental metrics analyses. The incremental compliance cost calculations for the stringent scenarios are thoroughly documented in each of the previous ONGPT Environmental Program metrics analysis reports and are not included in this retroactive environmental metrics report.

Table 2-2. Retroactive Metrics Analysis; Environmental Compliance Issues

Environmental Compliance Issue Area	Issue Included in Environmental Metrics			
	Retroactive	1996	1998	2000
Drilling and Drilling Waste Management				
1. Onshore Drilling Waste Management	X	X	X	X
2. Drilling Waste Reduction by Advanced Drilling Technology				X
3. Offshore Drilling Waste Management	X	X	X	X
4. Offshore Drilling; Synthetic Drill Fluids - regulatory	X	X	X	X
5. Offshore Drilling; Synthetic Drill Fluids - technology			X	X
6. Drilling in Wetlands - regulatory	X			X
7. Drilling in Wetlands; Mitigation - technology	X	X	X	X
Produced Water				
8. Onshore Produced Water Disposal (Surface and Coastal)	X,X	X	X	X
9. Onshore Produced Water; Volume Reduction - technology			X	X
10. Onshore Produced Water; Water Treatment - technology	X	X	X	X
11. Offshore Produced Water Disposal	X	X	X	X
12. Offshore Produced Water; Volume Reduction - technology			X	X
13. Offshore Produced Water; Lifting & Treatment - technology		X	X	X
Production Waste Management				
14. Associated Waste Management	X	X	X	X
15. Salt Cavern Disposal of E&P Waste - technology	X		X	X
16. NORM Waste Disposal	X	X	X	X
17. NORM Management & Minimization – technology			X	X
18. NORM Contaminated Equipment Disposal - technology			X	X
19. Emergency Pit Upgrade/Replacement	X	X		
Remediation				
20. Remediation; Hydrocarbon Contamination	X	X	X	X
21. Remediation; Hydrocarbon Contamination - technology			X	X
22. Remediation; Saltwater Contamination		X	X	X
23. Remediation; Saltwater Contamination - technology			X	X
24. Remediation; NORM Contaminated Soil			X	X
25. Remediation; NORM Contaminated Soil - technology				X
26. Remediation; Mercury Contamination		X	X	
27. Offshore Sediment Monitoring & Remediation	X	X	X	

Table 2-2, continued. Retroactive Metrics Analysis; Environmental Compliance Issues

Environmental Compliance Issue Area	Issue Included in Environmental Metrics			
	Retroactive	1996	1998	2000
Air Emissions				
28. Onshore Emissions Control, MACT Rule	X	X	X	X
29. Offshore Emissions Control	X	X	X	X
30. Regional Haze			X	X
31. Greenhouse Gas Emissions Reduction - technology			X	X
32. Enhanced Air Emissions Monitoring	X	X		
33. Risk Management Programs	X	X	X	
34. Title V Operating Permits	X	X		
Underground Injection				
35. Regulation of Hydraulic Fracturing	X		X	X
36. USDW Protection and Injection Well Construction	X	X	X	X
37. Area of Review; Existing Injection Wells	X	X	X	
38. Area of Review; New Injection Wells	X	X	X	X
39. Injection Well Mechanical Integrity Testing	X	X	X	
Spills, Discharge, Releases				
40. SPCC Plan	X	X	X	X
41. NPDES Storm Water Permitting	X	X	X	X
42. Toxic Release Inventory (TRI)	X	X	X	X
43. Aboveground Storage Tank Leak Protection	X	X	X	
44. Certificate of Financial Responsibility	X	X	X	
Regulatory Streamlining				
45. Regulatory Streamlining	X	X	X	X
Total Environmental Compliance Issue Areas	**31**	**30**	**39**	**35**

2.4. Oil and Gas Environmental Cost Model

2.4.1. General Environmental Cost Model Features

The Oil and Gas Environmental Cost Model was developed for the 1998 forward environmental metrics analysis and modified and enhanced for the 2000 environmental metrics analysis. The Oil and Gas Environmental Cost Model was designed to estimate the potential future environmental compliance cost savings associated with DOE activities. Given several compliance scenarios for each environmental issue, the Oil and Gas Environmental Cost model estimates the most likely incremental compliance cost outcome under one of three cases: (1) stringent regulation, (2) industry activity only, and (3) industry plus DOE activity (with DOE). The Oil and Gas Environmental Cost Model is written in Visual Basic 5 with data storage in Microsoft Access 97. The environmental cost model output consists of six database tables that correspond to the three cases (With DOE, Industry Only, and Stringent), with one set of database tables for oil and another set for natural gas. These database tables are run through a FORTRAN post-process to create data tables in a format that can be easily used by GSAM and OSAM.

As part of the 2000 environmental metrics analysis, the Oil and Gas Environmental Cost Model was redesigned to track environmental costs on a reservoir-specific basis (as opposed to state-level accounting, as had previously been the case). For scenarios where cost assignments can be made based on readily available, reservoir-specific data, those data are now used to assign the full scenario costs to the applicable wells. For example, costs associated with scenarios applicable only to coal bed methane are applied only to coal bed methane reservoirs as defined by the GSAM database; compliance costs associated with oil wells in the Rocky Mountains states are only applied to oil reservoirs in the appropriate states. In other cases, no readily available source of data can be identified for differentiating those reservoirs likely to be affected by a particular regulatory scenario from those unlikely to be affected. In these cases, a purely random assignment of costs is used to determine the wells to be affected or unaffected by a given regulatory scenario. The model design ensures that the costs are applied to a particular reservoir across all three cases (i.e., Stringent, Industry Only, and With DOE). In other words, if a reservoir is randomly assigned a compliance cost under the With DOE case, the incremental compliance costs are applied to the same reservoir under the Industry Only and Stringent cases.

In other cases, incomplete data are available that can be used to associate costs with particular reservoirs. In these cases, a combination of the two approaches is used which takes advantage of the limited amount of available data. For example, scenario costs applicable only to wells within wetlands rely upon incomplete data regarding the co-occurrence of wells and wetlands. Specifically, the percentage of each state that is covered by wetlands is known based on U.S. Department of Agriculture survey data. To apply that percentage to the reservoirs in the model, both reservoirs and wetlands are assumed to be evenly distributed across each state. Under this simplifying assumption, reservoirs can be assigned wetland-scenario costs in proportion to the statewide area under wetlands.

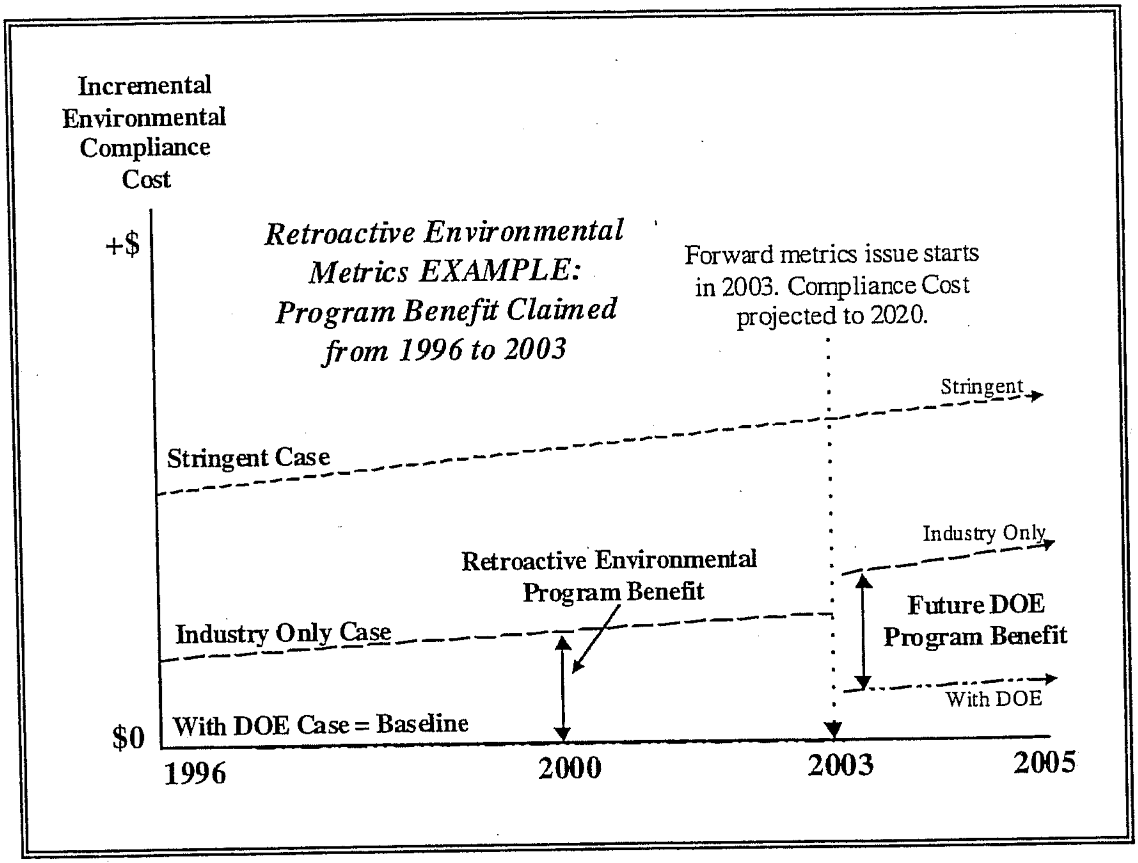
2.4.2. Retroactive Metrics Environmental Cost Model

Various features of the Oil and Gas Environmental Cost Model were modified for the retroactive environmental metrics analysis. For each environmental issue, the unit incremental compliance costs for the With DOE (baseline) and the Stringent cases are explicitly specified, so the Oil and Gas Environmental Cost model only estimates incremental compliance costs for the Industry Only case. An expected value or probabilistic approach is not used to estimate the Industry Only Case. Instead, the environmental program impact factor is explicitly specified for each issue. Although the incremental compliance costs are, for the most part, specified to the environmental cost model, the environmental cost model features are applied so that environmental compliance costs are applied on a reservoir-specific basis for the program implementation years assigned to each issue. For example, although incremental compliance costs for the Stringent case are specified to the environmental cost model and are not calculated by the model, the environmental cost model still selects the reservoirs that full Stringent case costs are applied to.

Furthermore, once reservoirs are selected for the Stringent case, the environmental cost model selects the same reservoirs to calculate and apply the costs for the Industry Only case.

The incremental compliance costs for each case, With DOE, Industry Only, and Stringent, are applied on a reservoir-specific basis for the program implementation years specified in Appendix B for each issue. For all environmental issues, the retroactive metrics analysis captures the past and current impact of ONGPT Environmental Program activities for the period 1996 to 2000. For some issues, however, it is appropriate to capture the near term future benefit of current Environmental Program activities up to and including the year 2005. The reason for the near term extension of the retroactive metrics analysis is to capture the Environmental Program benefits for each current environmental issue up to the year at which the issue is implemented in the 2000 forward environmental program metrics analysis. This is illustrated by an example in Figure 4. In Figure 4, the ONGPT Environmental Program has both past, current and projected ongoing impact on a particular environmental issue. The *future* program impact for 2003 to 2020 is estimated by the 2000 environmental metrics. The retroactive environmental metrics analysis estimates the past and current program impact for the period 1996 to 2000. If the retroactive metrics analysis stops at year 2000, the estimated near-term benefit of current and ongoing program activities during the years 2001 to 2003 are not captured by either the retroactive environmental metrics analysis or the 2000 forward environmental metrics analysis.

Figure 4. Retroactive Environmental Metrics; Near Term Future Benefit of Current Environmental Program Activities



2.5. Integrated Oil and Gas Systems Analysis Models (OSAM and GSAM)

2.5.1. General Features of Oil and Gas Systems Analysis Models

DOE's Oil System Analysis Model (OSAM) and Gas System Analysis Model (GSAM) are integrated, resource-based models designed for the comprehensive assessment of the impacts of cost, technology, infrastructure, regulatory initiatives, and development timing on U.S. oil and gas production. The Oil System Analysis Model framework was based upon and coordinated with the peer-reviewed modeling approach underlying DOE's Gas System Analysis Model (GSAM). A unique feature of OSAM and GSAM is reservoir-level analysis that evaluates exploration, development, and production at the level of over 20,000 individual reservoirs. The oil and gas reservoirs contained in OSAM and GSAM are obtained from the most recent release of the NRG Associates database, *Significant Oil and Gas Fields of the United States*. A resource description is provided for each reservoir, which consists of resource type, production characteristics, original-oil-place, annual and cumulative production, remaining reserves, reservoir fluid and mechanical properties, and reservoir rock properties. In OSAM and GSAM, the resource descriptions for the known reservoirs of the NRG Associates database are used to create a reservoir-level characterization of the United States undiscovered resource base defined by the U.S. Geological Survey's *1995 National Assessment of United States Oil and Gas Resources.*

Exploration drilling decisions in OSAM and GSAM are based on the anticipated field sizes and reservoir properties of the remaining undiscovered resource, as well as, exploration technology, market conditions, infrastructure availability, and alternative investment opportunities. The exploration forecast is not simply based on extrapolation of historical finding rates. Rather, exploration decision-making accounts explicitly for the geologic characteristics, exploration history, availability of improved technologies, oil price and the full costs associated with exploration. Reservoir development decisions are based upon an economic evaluation of each reservoir that incorporates income from forecast production, investment and operating costs, taxes, and forecast oil price. A discounted cash flow analysis is performed for each reservoir, and reservoirs are scheduled for development based on their relative economic attractiveness at a given price.

Exploration and production technology is modeled by simulating the effect of alternative technologies on ultimate oil recovery and reservoir production profiles. Technological advance is characterized either as a change in reservoir parameters, or as a change in economic parameters. In other words, technological advance may increase ultimate recovery, improve reservoir productivity, or lower the cost of production. OSAM and GSAM also feature project-specific financial decision-making, which considers all investment and operations decisions annually on a reservoir-level basis, and incorporates contemporary technology availability, market conditions, reservoir depletion, capital and infrastructure constraints, and regulatory requirements. Opportunities are evaluated on a risk-weighted, full-cost basis, and decisions are made as to which exploration and development projects are initiated, continued, or abandoned.

OSAM and GSAM incorporate Federal lands access scenarios that were developed for the Department of Energy and the Bureau of Land Management for modeling of onshore lower-48 Federal lease access and development issues. The Federal lands access and development scenarios for the With DOE and Without DOE cases are incorporated into the Oil and Gas System Analysis Models.[1] The With DOE and Without DOE cases assume different scenarios for future access to Federal lands for oil and gas exploration and development. The Without DOE case corresponds to current trends in the availability and development of Federal leases. The With DOE case assumes more proactive leasing and development of Federal lands. At present, onshore Federal lands in the lower-48 states are estimated to contain 11 percent of the remaining

[1] The technical approach used to develop Federal lands access and development scenarios is discussed in the report, *Access to Federal Lands, Bureau of Land Management Study,* prepared by ICF Consulting for U.S. Department of Energy and U.S. Bureau of Land Management, February 2000.

crude oil resource, 32 percent of the remaining natural gas resource, and 32 percent of the remaining natural gas liquids resource. Between 1985 and 1998, the national total number of Federal leases declined by 62 percent and the national total acreage leased declined by 79 percent. For the period 2000 to 2020, the Without DOE case assumes that 17 percent to 28 percent of the potential crude oil resource on Federal lands is produced, as well as 47 percent to 49 percent of the natural gas resource on Federal lands. The With DOE case assumes greater access to Federal leases and less restrictive development policies. Under the improved access scenario of the With DOE case, the Federal acreage available for lease increases by 20 percent each year for the period 2000 to 2020, and the time between leasing and initial development is reduced by twelve months.

As incremental environmental costs are provided to OSAM and GSAM, the models evaluate the impact on continued reservoir operation and new development. The resource-based models appropriately account for the fact that higher environmental costs will cause premature abandonment of some existing wells and will delay or prevent the development of some new wells. The magnitude of these impacts depends upon the magnitude of the incremental environmental costs. Consequently, production impacts will be different for each of the model cases specified. Since the Environmental Program targets both oil and natural gas exploration and development, the total impact of the ONGPT Environmental Program is the sum of the impacts derived from GSAM for natural gas exploration and production and from OSAM for crude oil exploration and production. The expected impact of the DOE Oil and Gas Environmental Program on incremental environmental compliance cost savings and other measures such as production, employment, public sector revenues, and royalty are determined by adding together the GSAM and OSAM outputs. The model results can also be compared against projected Environmental Program expenditures to estimate the present value of program benefits against dollars spent to sustain these activities (i.e., program dollar spent per barrel of oil or Mcf of gas; program dollars spent per dollar of public sector revenue received).

2.5.2. Retroactive Metrics Modifications to the Oil and Gas System Analysis Models

The Oil and Gas System Analysis Models are integrated resource-based models that are designed to forecast the future impacts of changes in exploration and production costs, technology, infrastructure, resource base, regulatory initiatives, and exploration and development timing. For forward-looking analyses such as the future environmental program metrics, the oil and natural gas price tracks in the models, as well as base year parameters such as production, generally correspond to the Reference Case of the current Energy Information Administration, *Annual Energy Outlook (AEO)*.

For the retroactive environmental metrics analysis, OSAM and GSAM parameters were modified so that the oil and gas production predicted by the models for the Baseline case for years 1995 through 1999 correspond to historical production to within 10 percent. The projected oil and gas production predicted by the models for the years 2000 to 2005 matches the *2000 AEO* Reference Case. Similarly, the oil and natural gas price tracks for the years 1995 through 1999 correspond to the annual average of actual prices for each year, and future price tracks for the period 2000 to 2005 correspond to the *2000 AEO* Reference Case. The retroactive environmental metrics analysis provided a first-time opportunity to modify the oil and gas analytical models to match prior production and evaluate the results. In consideration of the time limitations for completing the retroactive metrics analysis, as well as the level of precision in the incremental cost analysis, an acceptable match of model-predicted production to both historical production and the *2000 AEO* was determined to be 10 percent. Appendix C compares total oil and gas production predicted by OSAM and GSAM with historical production and the *2000 AEO*. The production match achieved for both models is within less than 10 percent in all years. For the oil model, the maximum variance for a single year is 5 percent. The average annual difference between model-predicted oil production and historical or *AEO* production for the period 1995 to 2005 is 2.4 percent. For the gas model, the maximum variance for a single year is 7 percent and the average annual difference during the period 1995 to 2005 is 4.9 percent.

3. RETROACTIVE ENVIRONMENTAL METRICS RESULTS

The results tables included in this section contain the combined results of the oil and gas analytical models. This means that that production, costs, revenue, etc. from both the oil and gas models are added together. For example, the natural gas production reported in Table 3-1 and Table 3-2 includes natural gas production from gas wells, as well as associated gas production from oil wells. Similarly, oil production reported in Table 3-1 and Table 3-2 includes the natural gas liquids or condensate production reported by GSAM, as well as the crude oil production projected by OSAM.

Table 3-1 reports the annual ONGPT Environmental Program impact for the period 1996 to 2005 as determined by the retroactive environmental metrics analysis. The results reported in Table 3-1 are the difference between the Industry Only case and the With DOE case (Baseline). Table 3-2 reports the total annual impact of the ONGPT Environmental Program in conjunction with industry efforts. The results reported in Table 3-2 are the difference between the With DOE case (Baseline) and the Stringent case. Table 3-2 represents the total estimated benefit derived from the combined efforts of industry plus the DOE Environmental Program to avoid the Stringent case outcomes for the various environmental issues considered.

Table 3-3 reports cumulative ONGPT Environmental Program impact for the periods 1996 to 2000 and 1996 to 2005, for comparison with cumulative results reported for the 1996 forward environmental metrics analysis. Table 3-3 also reports the cumulative Environmental Program impact for the period 1998 to 2005, for comparison with the 1998 Environmental Program metrics, as well as the period 2000 to 2005 for comparison with the 2000 Environmental Program metrics. Table 3-4 reports the total cumulative impact of ONGPT Environmental Program efforts together with industry efforts to deter stringent regulatory outcomes.

For the five-year period from 1996 to 2000, ONGPT Environmental Program activities contributed an estimated 100 million barrels of incremental oil and 600 billion cubic feet of incremental natural gas that otherwise might not have been produced. During the same period, the ONGPT Environmental Program is estimated to have provided more than $5.4 billion in environmental compliance cost savings and more than $1 billion in total government revenue. Environmental Program activities are estimated to have contributed almost 8,000 labor-years of direct industry employment, or approximately 1,600 industry jobs.

If an estimated future benefit of current ONGPT Environmental Program activities is also captured, during the ten-year period from 1996 to 2005, the Environmental Program contributes almost 329 million barrels of oil and almost 1.9 trillion cubic feet of natural gas. During the same period the ONGPT Environmental Program is estimated to provide more than $9.7 billion in environmental compliance cost savings and $4.3 billion in total government revenue. From 1996 to 2005, Environmental Program activities are estimated to contribute more than 27,000 labor-years of direct industry employment, or approximately 2,700 industry jobs.

The overall percentage contribution of the ONGPT Environmental Program can be estimated for the period 1996 to 2005 by comparing the cumulative results from Table 3-3, ONGPT Environmental Program Impact, with the cumulative results for the Stringent case shown in Table 3-4. For example, during 1996 to 2000, the total benefit of industry plus DOE working together to avert the Stringent case contributed an estimated 258 million barrels of oil and 2.65 trillion cubic feet of natural gas. Approximately 107 million barrels of this incremental oil production, or 41 percent, may be attributed to ONGPT Environmental Program activities. Approximately 609 billion cubic feet of incremental gas production, or 23 percent, may be attributed to the ONGPT Environmental Program. Similarly, from 1996 to 2000, an estimated $22.8

billion in total of compliance cost savings resulted from avoiding the Stringent case. Approximately, $5.4 billion, or almost 24 percent may be attributed to the ONGPT Environmental Program.

Table 3-1. Retroactive Metrics Combined Oil and Gas Model Results; Annual ONGPT Environmental Program Impact (Industry with DOE Case) – (Industry Only Case)

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Oil & NGL Production, Million Barrels	1	5	19	43	39	43	63	32	42	43
Gas Production, Bcf	-5	30	138	215	231	211	243	167	291	371
Total Adjusted Industry Revenue, Million $	-$13	$139	$517	$915	$933	$982	$1,371	$876	$1,334	$1,422
Total Royalties, Million $	-$2	$17	$64	$114	$117	$122	$171	$109	$167	$202
Total Federal Royalties, Million $	-$11	-$7	$34	$50	$53	$38	$72	$28	$89	$134
Total Environmental Investments, Million $	-$2,975	-$274	-$324	-$333	-$490	-$486	-$533	-$548	-$586	-$36
Total Environmental O&M Costs, Million $	-$184	-$292	-$120	-$164	-$291	-$352	-$386	-$421	-$459	-$461
Operator Severance Taxes, Million $	$5	$13	$23	$39	$39	$53	$61	$59	$75	$86
State Income Taxes, Million $	$21	-$13	-$1	$10	$16	$25	$29	$30	$26	$32
Federal Income Taxes, Million $	$226	-$58	$93	$222	$285	$373	$550	$418	$564	$562
State Government Revenues, Million $	$20	-$4	$39	$74	$82	$96	$125	$102	$145	$184
Federal Government Revenues, Million $	$221	-$61	$109	$247	$312	$392	$586	$432	$608	$629
Total Government Revenues, Million $	$241	-$64	$148	$321	$394	$488	$712	$534	$753	$813
Industry Employment, Job-Years	-41	446	1,654	2,927	2,986	3,143	4,387	2,803	4,268	4,550
Total Employment, Job-Years	-114	1,255	4,653	8,232	8,397	8,839	12,339	7,884	12,003	12,798

Table 3-2. Retroactive Metrics Combined Oil and Gas Model Results; Total Annual ONGPT Environmental Program plus Industry Impact (Industry with DOE Case) – (Stringent Case)

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Oil & NGL Production, Million Barrels	13	26	54	79	86	110	111	112	105	97
Gas Production, Bcf	387	326	554	612	766	891	752	717	843	881
Total Adjusted Industry Revenue, Million $	$868	$1,086	$1,714	$2,016	$2,453	$3,215	$3,060	$3,219	$3,524	$3,661
Total Royalties, Million $	$109	$136	$214	$252	$319	$404	$403	$421	$458	$475
Total Federal Royalties, Million $	-$3	$2	$74	$70	$118	$135	$114	$108	$149	$178
Total Environmental Investments, Million $	-$12,546	-$614	-$711	-$751	-$1,105	-$1,136	-$1,306	-$1,320	-$1,360	$98
Total Environmental O&M Costs, Million $	-$1,515	-$1,750	-$1,038	-$1,241	-$1,530	-$1,529	-$1,601	-$1,532	-$1,553	-$1,500
Operator Severance Taxes, Million $	$50	$62	$80	$101	$124	$161	$159	$177	$191	$190
State Income Taxes, Million $	$155	$39	$32	$53	$64	$77	$84	$88	$95	$82
Federal Income Taxes, Million $	$1,382	$461	$601	$795	$1,005	$1,336	$1,422	$1,467	$1,631	$1,391
State Government Revenues, Million $	$203	$102	$149	$188	$248	$306	$301	$320	$360	$361
Federal Government Revenues, Million $	$1,380	$462	$638	$830	$1,064	$1,404	$1,479	$1,521	$1,706	$1,480
Total Government Revenues, Million $	$1,583	$564	$787	$1,018	$1,311	$1,710	$1,780	$1,841	$2,066	$1,841
Industry Employment, Job-Years	2,778	3,475	5,485	6,452	7,850	10,288	9,793	10,300	11,276	11,716
Total Employment, Job-Years	7,813	9,774	15,426	18,148	22,078	28,935	27,542	28,967	31,715	32,952

Table 3-3. Retroactive Metrics Combined Oil and Gas Model Results; Cumulative ONGPT Environmental Program Impact (Industry with DOE Case) – (Industry Only Case)

Industry with DOE Case – Industry Only Case	1996 - 2000	1996 - 2005	*1998 - 2005*	*2000 - 2005*
Oil & NGL Production, Million Barrels	107	329	*323*	*261*
Gas Production, Bcf	609	1,892	*1,867*	*1,514*
Total Adjusted Industry Revenue, Million $	$2,491	$8,476	*$8,350*	*$6,918*
Total Royalties, Million $	$312	$1,083	*$1,068*	*$889*
Total Federal Royalties, Million $	$120	$479	*$497*	*$413*
Total Environmental Investments, Million $	-$4,396	-$6,586	*-$3,337*	*-$2,680*
Total Environmental O&M Costs, Million $	-$1,051	-$3,129	*-$2,653*	*-$2,370*
Operator Severance Taxes, Million $	$119	$452	*$434*	*$372*
State Income Taxes, Million $	$32	$174	*$166*	*$157*
Federal Income Taxes, Million $	$769	$3,236	*$3,068*	*$2,753*
State Government Revenues, Million $	$211	$864	*$848*	*$734*
Federal Government Revenues, Million $	$828	$3,476	*$3,316*	*$2,960*
Total Government Revenues, Million $	$1,039	$4,340	*$4,163*	*$3,694*
Industry Employment, Job-Years	7,973	27,124	*26,718*	*22,137*
Total Employment, Job-Years	22,423	76,286	*75,146*	*62,260*

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Table 3-4. Retroactive Metrics Combined Oil and Gas Model Results; Cumulative Total ONGPT Environmental Program plus Industry Impact (Industry with DOE Case) – (Stringent Case)

Industry with DOE Case – Stringent Case	1996 - 2000	1996 - 2005	1998 - 2005	2000 - 2005
Oil & NGL Production, Million Barrels	258	794	*755*	*622*
Gas Production, Bcf	2,645	6,727	*6,014*	*4,848*
Total Adjusted Industry Revenue, Million $	$8,138	$24,817	*$22,863*	*$19,132*
Total Royalties, Million $	$1,029	$3,190	*$2,946*	*$2,480*
Total Federal Royalties, Million $	$261	$945	*$947*	*$803*
Total Environmental Investments, Million $	-$15,728	-$20,752	*-$7,592*	*-$6,129*
Total Environmental O&M Costs, Million $	-$7,073	-$14,788	*-$11,524*	*-$9,245*
Operator Severance Taxes, Million $	$417	$1,295	*$1,183*	*$1,002*
State Income Taxes, Million $	$342	$769	*$575*	*$491*
Federal Income Taxes, Million $	$4,244	$11,491	*$9,648*	*$8,252*
State Government Revenues, Million $	$889	$2,536	*$2,232*	*$1,895*
Federal Government Revenues, Million $	$4,374	$11,964	*$10,122*	*$8,653*
Total Government Revenues, Million $	$5,263	$14,500	*$12,353*	*$10,548*
Industry Employment, Job-Years	26,041	79,413	*73,160*	*61,223*
Total Employment, Job-Years	73,239	223,350	*205,763*	*172,189*

4. RETROACTIVE METRICS RESULTS COMPARED WITH PREVIOUS ENVIRONMENTAL PROGRAM METRICS

The tables in this section compare the cumulative results from the retroactive metrics results with corresponding cumulative results from the 1996, 1998, and 2000 forward environmental metrics analyses. Table 4-1 compares the cumulative results from the With DOE minus Industry Only case for the retroactive metrics and 1996 environmental metrics. Table 4-2 compares the cumulative results from the With DOE case minus Stringent case for the retroactive metrics and the 1996 forward environmental metrics. Both Tables 4-1 and 4-2 show remarkable agreement between the retroactive metrics results and the 1996 forward environmental metrics. This suggests that the 1996 environmental metrics forecast of the future impact of the ONGPT Environmental Program is corroborated by the "look backward" provided by the retroactive metrics analysis.

Table 4-3 compares the cumulative retroactive metrics results with the 1998 forward environmental metrics. Because a Stringent case was not developed for the 1998 environmental metrics analysis, Table 4-3 only provides the results of the With DOE case minus Industry Only case. Table 4-4 shows the cumulative model results for the With DOE minus Industry Only case for the retroactive metrics, as well as the corresponding model results from the 2000 environmental metrics analysis. Table 4-5 presents the model results for the Stringent case for both the retroactive metrics analysis and the 2000 environmental metrics.

The retroactive metrics model results for the period 2000 to 2005 represent a near-term future projection of current ONGPT Environmental Program activities. At the level of individual environmental compliance issues, the retroactive metrics results represent the impact of ONGPT Environmental Program activities for the period from 1996 up to the year in which the issue is implemented in the 2000 forward environmental metrics. Consequently, the retroactive metrics model results for 2000 to 2005 provide an estimated incremental Environmental Program benefit that should be *added* to the Environmental Program benefit projected by the 2000 environmental metrics analysis. For example, in Table 4-4 the 2000 environmental metrics analysis forecasts 514 million barrels of incremental oil production from future ONGPT Environmental Program activities during 2000 to 2005. The 2000 environmental metrics model results incorporate estimated future ONGPT Environmental Program impacts on compliance technologies such as downhole oil/water separation and regulatory issues such as greenhouse gas emissions - issues which are not included in the retroactive metrics analysis. The retroactive metrics analysis forecasts a total of 261 million barrels of incremental oil production resulting from current Environmental Program impacts on individual environmental compliance issues *during the years before the issues' 2000 environmental metrics analysis*. The total impact of ONGPT Environmental Program activities for the period 2000 to 2005 may be estimated as the sum of the model results from the retroactive metrics analysis and the corresponding model results from the 2000 environmental metrics analysis. Consequently, the total Environmental Program impact on incremental oil production for the period 2000 to 2005 may be estimated as 775 million barrels. Similarly, Table 4-4 shows that the total Environmental Program impact on incremental gas production for 2000 to 2005 may be estimated as approximately 3.0 trillion cubic feet.

Table 4-1. Retroactive Metrics Combined Oil and Gas Model Results; Cumulative Total ONGPT Environmental Program Impact; Comparison with 1996 Forward Environmental Metrics Results

Industry with DOE Case – Industry Only Case	Retroactive Metrics		1996 Environmental Metrics	
	1996 - 2000	1996 - 2005	1996 - 2000	1996 - 2005
Oil & NGL Production, Million Barrels	107	329	90	310
Gas Production, Bcf	609	1,892	350	1,010
Total Adjusted Industry Revenue, Million $	$2,491	$8,476	$2,400	$8,000
Total Environmental Costs (Investments plus O&M), Million $	-$5,446	-$9,715	-$2,900	-$8,700
State Government Revenues, Million $	$211	$864	$200	$800
Federal Government Revenues, Million $	$828	$3,476	$700	$2,800
Total Government Revenues, Million $	$1,039	$4,340	$900	$3,600
Industry Employment, Job-Years	7,973	27,124	7,680	25,600
Total Employment, Job-Years	22,423	76,286	22,187	73,781

Table 4-2. Retroactive Metrics Combined Oil and Gas Model Results; Cumulative Total ONGPT Environmental Program Plus Industry Impact; Comparison with 1996 Forward Environmental Metrics Results

Industry with DOE Case – Stringent Case	Retroactive Metrics		1996 Environmental Metrics	
	1996 - 2000	1996 - 2005	1996 - 2000	1996 - 2005
Oil & NGL Production, Million Barrels	258	794	600	1,600
Gas Production, Bcf	2,645	6,727	4,000	9,500
Total Adjusted Industry Revenue, Million $	$8,138	$24,817	$14,890	$44,900
Federal Government Revenues, Million $	$4,374	$11,964	$4,000	$13,600
Total Government Revenues, Million $	$5,263	$14,500	$5,100	$17,600
Industry Employment, Job-Years	26,041	79,413	47,650	143,680
Total Employment, Job-Years	73,239	223,350	134,030	404,120

Table 4-3. Retroactive Metrics Combined Oil and Gas Model Results; Cumulative Total ONGPT Environmental Program Impact; Comparison with 1998 Forward Environmental Metrics Results

Industry with DOE Case – Industry Only Case	Retroactive Metrics	1998 Environmental Metrics
	1998 - 2005	1998 - 2005
Oil & NGL Production, Million Barrels	*323*	305
Gas Production, Bcf	*1,867*	2,111
Total Adjusted Industry Revenue, Million $	*$8,350*	$9,728
Total Royalties, Million $	*$1,068*	$1,169
Total Federal Royalties, Million $	*$497*	$603
Total Environmental Costs (Investments plus O&M), Million $	*-$5,990*	-$7,793
State Government Revenues, Million $	*$848*	$1,285
Federal Government Revenues, Million $	*$3,316*	$3,933
Total Government Revenues, Million $	*$4,163*	$5,217
Industry Employment, Job-Years	*26,718*	31,130
Total Employment, Job-Years	*75,146*	87,551

Table 4-4. Retroactive Metrics Combined Oil and Gas Model Results; Cumulative Total ONGPT Environmental Program Impact; Comparison with 2000 Forward Environmental Metrics Results

Industry with DOE Case – Industry Only Case	Retroactive Metrics	2000 Environmental Metrics
	2000 - 2005	2000 - 2005
Oil & NGL Production, Million Barrels	*261*	514
Gas Production, Bcf	*1,514*	1,543
Total Adjusted Industry Revenue, Million $	*$6,918*	$10,632
Total Royalties, Million $	*$889*	$1,330
Total Federal Royalties, Million $	*$413*	$485
Total Environmental Costs (Investments plus O&M), Million $	*-$5,050*	-$10,957
State Government Revenues, Million $	*$734*	$1,000
Federal Government Revenues, Million $	*$2,960*	$5,314
Total Government Revenues, Million $	*$3,694*	$6,314
Industry Employment, Job-Years	*22,137*	36,000
Total Employment, Job-Years	*62,260*	94,000

Table 4-5. Retroactive Metrics Combined Oil and Gas Model Results; Cumulative Total ONGPT Environmental Program Plus Industry Impact; Comparison with 2000 Forward Environmental Metrics Results

Industry with DOE Case – Stringent Case:	Retroactive Metrics	2000 Environmental Metrics
	2000 - 2005	2000 - 2005
Oil & NGL Production, Million Barrels	*622*	877
Gas Production, Bcf	*4,848*	2,226
Total Adjusted Industry Revenue, Million $	*$19,132*	$17,552
Total Royalties, Million $	*$2,480*	$2,166
Total Federal Royalties, Million $	*$803*	$520
Total Environmental Costs (Investments plus O&M), Million $	*-$15,374*	-$13,905
State Government Revenues, Million $	*$1,895*	$1,777
Federal Government Revenues, Million $	*$8,653*	$10,173
Total Government Revenues, Million $	*$10,548*	$11,950
Industry Employment, Job-Years	*61,223*	56,200
Total Employment, Job-Years	*172,189*	158,000

5. DATA SOURCES

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Appendix A. Retroactive Metrics Model Results

Table A.1. Oil Model (OSAM) Results Summary; Annual ONGPT Environmental Program Impact; (Industry with DOE Case) – (Industry Only Case)

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Oil & NGL Production, Million Barrels	0	5	18	43	39	43	63	32	42	43
Associated Gas Production, Bcf	-11	-6	17	36	47	35	63	17	56	62
Total Adjusted Industry Revenue, Million $	-$22	$67	$275	$548	$544	617	994	$554	$815	$711
Total Royalties, Million $	-$3	$8	$34	$68	$68	$77	$124	$69	$102	$113
Total Federal Royalties, Million $	-$12	-$12	$12	$16	$21	$13	$48	$16	$57	$84
Total Environmental Investments, Million $	-$2,130	-$168	-$184	-$170	-$216	-$275	-$300	-$302	-$311	-$53
Total Environmental O&M Costs, Million $	-$401	-$397	-$131	-$74	-$99	-$77	-$56	-$54	-$55	-$42
Operator Severance Taxes, Million $	$4	$8	$11	$21	$21	$37	$42	$42	$51	$56
State Income Taxes, Million $	$14	$7	$3	$10	$8	$12	$15	$13	$18	$16
Federal Income Taxes, Million $	$52	$11	$50	$102	$87	$164	$308	$169	$284	$309
State Government Revenues, Million $	$11	$9	$20	$39	$40	$55	$80	$62	$97	$113
Federal Government Revenues, Million $	$47	$6	$55	$110	$98	$171	$332	$177	$312	$351
Total Government Revenues, Million $	$58	$15	$75	$149	$138	$225	$413	$239	$409	$464
Industry Employment, Job-Years	-69	216	880	1,753	1,741	1,975	3,181	1,773	2,607	2,897
Total Employment, Job-Years	-195	607	2,475	4,929	4,896	5,554	8,946	4,990	7,332	8,147

Table A.2. Gas Model (GSAM) Results Summary; Annual ONGPT Environmental Program Impact; (Industry with DOE Case) – (Industry Only Case)

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Gas Production, Bcf	6	36	121	179	184	176	180	150	235	309
NGL Production, Million Barrels	0.38	0.08	0.68	0.17	0.18	0.16	0.06	-0.05	0.01	-0.04
Total Adjusted Industry Revenue, Million $	$9	$72	$242	$367	$389	$365	$377	$322	$519	$711
Total Royalties, Million $	$1	$9	$30	$46	$49	$45	$47	$40	$65	$89
Total Federal Royalties, Million $	$1	$5	$22	$34	$32	$25	$24	$12	$32	$50
Total Environmental Investments, Million $	-$845	-$106	-$140	-$163	-$274	-$211	-$233	-$246	-$275	$17
Total Environmental O&M Costs, Million $	$217	$105	$11	-$90	-$192	-$275	-$330	-$367	-$404	-$419
Operator Severance Taxes, Million $	$1	$5	$12	$18	$18	$16	$19	$17	$24	$30
State Income Taxes, Million $	$7	-$20	-$4	$0	$8	$13	$14	$17	$8	$16
Federal Income Taxes, Million $	$174	-$69	$43	$120	$198	$209	$242	$249	$280	$253
State Government Revenues, Million $	$9	-$13	$19	$35	$42	$42	$45	$40	$48	$71
Federal Government Revenues, Million $	$175	-$67	$54	$137	$214	$222	$254	$255	$296	$278
Total Government Revenues, Million $	$183	-$79	$73	$172	$256	$263	$299	$295	$344	$349
Industry Employment, Job-Years	29	230	774	1,174	1,245	1,168	1,206	1,030	1,661	2,275
Total Employment, Job-Years	81	648	2,178	3,303	3,501	3,285	3,393	2,898	4,671	6,399

Table A.3. Oil Model (OSAM) Results Summary; Total ONGPT Environmental Program plus Industry Impact; (Industry with DOE Case) – (Stringent Case)

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Oil & NGL Production, Million Barrels	8	20	49	74	80	105	106	107	101	94
Associated Gas Production, Bcf	-2	12	57	66	85	125	100	74	97	96
Total Adjusted Industry Revenue, Million $	$124	$366	$720	$878	$992	$1,596	$1,672	$1,828	$1,868	$1,849
Total Royalties, Million $	$16	$46	$90	$110	$136	$202	$229	$247	$250	$248
Total Federal Royalties, Million $	-$10	-$6	$25	$5	$26	$32	$48	$52	$73	$97
Total Environmental Investments, Million $	-$10,057	-$411	-$437	-$390	-$476	-$677	-$788	-$789	-$776	-$121
Total Environmental O&M Costs, Million $	-$1,520	-$1,413	-$441	-$332	-$361	-$184	-$171	-$78	-$79	-$42
Operator Severance Taxes, Million $	$11	$22	$29	$44	$48	$81	$87	$99	$103	$103
State Income Taxes, Million $	$67	$39	$13	$22	$21	$32	$40	$37	$45	$39
Federal Income Taxes, Million $	$460	$285	$209	$206	$194	$464	$560	$594	$673	$644
State Government Revenues, Million $	$72	$58	$54	$68	$83	$129	$152	$163	$184	$190
Federal Government Revenues, Million $	$455	$282	$221	$209	$207	$480	$584	$620	$710	$692
Total Government Revenues, Million $	$527	$340	$276	$276	$289	$610	$736	$783	$894	$883
Industry Employment, Job-Years	397	1,171	2,304	2,811	3,175	5,107	5,351	5,848	5977	5,918
Total Employment, Job-Years	1,117	3,294	6,480	7,906	8,929	14,364	15,050	16,448	16811	16,644

Table A.4. Gas Model (GSAM) Results Summary; Total ONGPT Environmental Program plus Industry Impact; (Industry with DOE Case) – (Stringent Case)

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Gas Production, Bcf	389	314	497	546	681	766	652	643	746	785
NGL Production, Million Barrels	5.52	5.59	4.98	4.85	6.08	5.73	5.16	4.60	4.11	3.57
Total Adjusted Industry Revenue, Million $	$744	$720	$994	$1,138	$1,461	$1,619	$1,388	$1,391	$1,656	$1,812
Total Royalties, Million $	$93	$90	$124	$142	$183	$202	$174	$174	$208	$227
Total Federal Royalties, Million $	$7	$8	$49	$65	$92	$103	$66	$56	$76	$81
Total Environmental Investments, Million $	-$2,489	-$203	-$274	-$361	-$629	-$459	-$518	-$531	-$584	$219
Total Environmental O&M Costs, Million $	$5	-$337	-$597	-$909	-$1,169	-$1,345	-$1,430	-$1,454	-$1,474	-$1,458
Operator Severance Taxes, Million $	$39	$40	$51	$57	$76	$80	$72	$78	$88	$87
State Income Taxes, Million $	$88	$0	$19	$31	$43	$45	$44	$51	$50	$43
Federal Income Taxes, Million $	$922	$176	$392	$589	$811	$872	$862	$873	$958	$747
State Government Revenues, Million $	$131	$44	$95	$121	$165	$177	$149	$157	$176	$171
Federal Government Revenues, Million $	$926	$180	$417	$622	$857	$924	$895	$901	$996	$788
Total Government Revenues, Million $	$1,056	$224	$511	$742	$1,022	$1,100	$1,044	$1,058	$1,172	$958
Industry Employment, Job-Years	2,381	2,304	3,181	3,642	4,675	5,181	4,442	4,451	5,299	5,798
Total Employment, Job-Years	6,696	6,480	8,946	10,242	13,149	14,571	12,492	12,519	14,904	16,308

APPENDIX B. UNIT COST SUMMARY SHEETS

1. DRILLING WASTE: Onshore Drilling Waste Management (Regulatory Issue)

Scenarios	Estimated Incremental Environmental Compliance Cost ($/well)		Type of Cost	Applied to	Years	DOE Program Impact Factor	DOE Program Activities
	Oil	Gas					
DOE plus Industry; Baseline. • Drilling with open mud system allowed. • Most reserve pits are lined. • Most drilling waste from fresh water based drilling operations is disposed on site.	**$0**	**$0**	Capital Cost	New Wells	1996 to 2004	**0.40**	• Advocate & support risk-based regulatory analysis and decision-making process. • Comment on rule-makings as appropriate through cooperative efforts with states, EPA and industry. • State Review Process • Technical workshops, conferences • IOGCC waste minimization guidelines • DRI Study • 17 State Study • Cumulative Impacts Study EPA/RCRA • Grand Bois air monitoring
Stringent Case. • Loss of RCRA exemption for E&P wastes • All wells drilled w/ closed mud system. • All drilling wastes are tested prior to disposal. • Hazardous waste disposed at a hazardous waste disposal facility. • On site waste disposal prohibited. All wastes disposed off site at commercial E&P waste facility. Average transport distance of 75 miles assumed.	Appalachian States: **$29,000** Non-Appalachian States: **$39,000**	Appalachian States: **$4,800** Non-Appalachian States: **$48,000**	Capital Cost	New Wells	1996 to 2004		

2. DRILLING & DRILLING WASTE: Offshore Drilling Waste Management (Regulatory Issue)							
Scenarios	Estimated Incremental Environmental Compliance Cost ($/well)		Type of Cost	Applied to	Years	DOE Program Impact Factor	DOE Program Activities
	Oil	Gas					
DOE plus Industry; Baseline. • Zero discharge of drilling fluids and cuttings from operations within three miles of shore. • Discharge in Cook Inlet allowed per offshore effluent limitation guidelines.	**$0**	**$0**	Capital Cost	New Offshore Wells	1996 to 2005	**0.25**	• Interagency collaboration • Support research on waste management technologies: data collection, dialog • Comment on coastal effluent limitation rulemaking. (e.g., economic/energy impact analysis) • Participate in various studies: TCLP validation; Toxicity Testing Technology; Continental Shelf Associates Study on discharge in Gulf of Mexico; Brookhaven Risk Assessment Study.
Stringent Case. • Zero discharge required for all offshore drilling including Cook Inlet with disposal onshore in an E&P waste facility.	CA: **$610,000** Cook Inlet, AK: **$1,214,000** Gulf of Mexico: **$635,000**	CA: **$610,000** Cook Inlet, AK: **$1,214,000** Gulf of Mexico: **$635,000**	Capital Cost	New Offshore Wells	1996 to 2005		

3. DRILLING & DRILLING WASTE: Offshore Drilling with Synthetic Drilling Fluids (Regulatory Issue)							
Scenarios	Estimated Incremental Environmental Compliance Cost ($/well)		Type of Cost	Applied to	Years	DOE Program Impact Factor	DOE Program Activities
	Oil	Gas					
DOE plus Industry; Baseline. • Current industry practice is discharge of cuttings from drilling operations using synthetic drilling fluids. • No use & discharge of synthetic drilling fluids in CA Federal offshore or in Cook Inlet, AK. • Best available solids control technology required after 1999.	**$0**	**$0**	Capital Cost	New Offshore Wells	1996 to 2002	**0.50**	• Interagency Collaboration. • Leadership of synthetic drilling fluid discussion group. • Comments on synthetic drilling fluid rulemaking. • Human Health Risk Assessment and other assistance to EPA. • Argonne National Laboratory summary report on synthetic drilling fluids.
Stringent Case. • Zero discharge of synthetic based drilling fluids and cuttings from synthetic based drilling operations. • All drilling waste from drilling with synthetic based fluids must be barged onshore for disposal or be disposed in offshore injection wells.	Gulf of Mexico: **$230,000** CA: **$134,000** Cook Inlet: **$100,000**	Gulf of Mexico: **$230,000** CA: **$134,000** Cook Inlet: **$100,000**	Capital Cost	GOM: 20% new wells plus dry holes CA: 50% new wells plus dryholes Cook Inlet: 15% new wells plus dryholes	1996 to 2002		

4. DRILLING & DRILLING WASTE: Drilling in Wetlands (Regulatory Issue)							
Scenarios	Estimated Incremental Environmental Compliance Cost ($/well)		Type of Cost	Applied to	Years	DOE Program Impact Factor	DOE Program Activities
	Oil	Gas					
DOE plus Industry; Baseline. • Assumes 10% of wells drilled in wetlands already incur some cost for mitigation efforts or permit fees. • Assumes 10% of wells drilled in wetlands are horizontal or directionally drilled wells. • Assumes average horizontal drilling cost is approximately 1.5x the average vertical drilling cost.	**$0**	**$0**			1996 to 2001	**0.20**	• Advocate & support risk-based regulatory analysis and decision-making process pertaining to access issues. • API wetlands committee • Funded Mitigation Banking Conference • Wetlands Restoration Research • Hovercraft Research • Impacts of Dead-end Canals • Existing Reserves in Wetlands • Series of Transportation studies • Impacts of expanding operations in existing wetlands fields • ANL: wetlands mitigation banking with API, GRI, etc • Metairie, LA site office
Stringent Case. • Seventy-five percent of new wells drilled in wetlands are drilled by a horizontal or directional technique. • Twenty-five percent of new wells drilled in wetlands incur a mitigation cost. • Full incremental compliance cost is applied only to wells estimated drilled in wetlands.	**$135,000**	**$240,000**	Capital Cost	Full Cost to % of New Wells in Wetlands	1996 to 2001		

5. DRILLING & DRILLING WASTE: Drilling in Wetlands (Compliance Technology R&D)

Scenarios	Estimated Incremental Environmental Compliance Cost		Type of Cost	Applied to	Years	DOE Program Impact Factor	DOE Program Activities
	Oil	Gas					
DOE plus Industry; Baseline. • Current Technologies used for drilling in wetlands : slimhole, directional & horizontal drilling, coiled tubing technology, and light modular drilling rig.	**$0**	**$0**	Capital	New Wells	1996 to 2002	**0.10**	• Support research on alternative drilling technologies to minimize damage to sensitive environments. • Support research on wetland restoration and waste management alternatives. • Wetlands mitigation/restoration research includes mitigation banking studies, alternatives methods, drill cuttings for wetland restoration, and beach erosion control technology • Support wetlands mitigation banking conference
Limited Technology R&D Case. • Fewer drilling opportunities & less drilling if current technologies were not available to minimize drilling "footprint".	**$39,050**	**$70,150**	Capital	New Wells (Apply full cost to % of wells drilled in wetlands)	1996 to 2002		

6. DRILLING & DRILLING WASTE: Emergency Pit Upgrade/Replacement (Regulatory Issue)

Scenarios	Estimated Incremental Environmental Compliance Cost		Type of Cost	Applied to	Years	DOE Program Impact Factor	DOE Program Activities
	Oil	Gas					
DOE plus Industry; Baseline. • Emergency/reserve pits regulated at state level in partnership with EPA, tribal governments, & industry. • Some states closing pits & ponds & requiring enclosed tanks. • Some states require pit lining & netting over operating pits.	$0	$0	Capital	Existing & New Wells	1996 to 2000	**0.05**	• Advocacy for risk-based regulatory decision-making. • Comments/input to states to assure that any new regulations are risk-based. • Regulatory guidance documents.
Stringent Case. • All existing pits must be closed and replaced with tanks. • All new facilities must be replaced by tanks according to the following assumptions: tanks batteries, a 1,000-gallon tank; saltwater disposal facility, two 500 -gallon tanks; evaporation/blowdown (E/B) facility, a 500 gallon tank.	**$6000** **$3,200**	**$4,200** **$2,200**	Capital Capital	Existing New (Apply full cost to 75% of new wells and 15% of existing wells)	1996 to 2000		

7. PRODUCED WATER MANAGEMENT: Onshore Produced Water Disposal; Surface Discharge (Regulatory Issue)							
Scenarios	**Estimated Incremental Environmental Compliance Cost**		**Type of Cost**	**Applied to**	**Years**	**DOE Program Impact Factor**	**DOE Program Activities**
	Oil	**Gas**					
DOE plus Industry; Baseline. • Surface discharges are allowed to continue in regions where currently allowed.	**$0**	**$0**	Capital & Annual	New & Existing Wells	1996 to 2005	**0.10**	• Advocate & support risk-based regulatory analysis and decision-making process pertaining to produced water disposal and independent operators. • NPC study on marginal wells highlighting high cost of water disposal. • Cost analyses of produced water disposal (ANL)
Stringent Case. • All surface discharge and beneficial use of produced water is prohibited. • This significantly increases incremental water disposal costs in selected regions. • The volume of produced water requiring disposal by injection ranges from 10% to 93% depending upon the state.	Appalachian States: **$30,000** **& $6300** Rocky Mtn. Region: **$4000** **$850** CA: **$9300** **& $2000**	AL Coalbed Methane: **$38,000** **$7900**	Capital Cost Annual Cost Capital Annual Capital Annual	New Wells New & Existing Wells New Wells New & Existing New New and Existing	1996 to 2005		

8. PRODUCED WATER MANAGEMENT: Coastal Produced Water Discharge, Cook Inlet, AK (Regulatory Issue)							
Scenarios	Estimated Incremental Environmental Compliance Cost		Type of Cost	Applied to	Years	DOE Program Impact Factor	DOE Program Activities
	Oil	Gas					
DOE plus Industry; Baseline. • Produced water discharge in Cook Inlet continues.	$0	$0	Capital & Annual	New and Existing Cook Inlet wells	1996 to 2003	0.20	• Advocacy for risk-based regulatory decision-making. • Economic Impact Assessments • Analysis of produced water discharge for Coastal Effluents Limitation rule • Technical evaluation and comments to EPA on Coastal Effluent Limitation rule. • LA Open Bay Analysis • Contribution of Cook Inlet to coastal discharge.
Stringent Case. • Produced water discharge in Cook Inlet is prohibited after stringent effluent limitations are adopted.	$330,800 $33,470	$330,800 $33,470	Capital Annual	New Cook Inlet wells New and Existing Cook Inlet wells	1996 to 2003		

9. PRODUCED WATER MANAGEMENT: Offshore Produced Water Disposal (Regulatory Issue)

Scenarios	Estimated Incremental Environmental Compliance Cost		Type of Cost	Applied to	Years	DOE Program Impact Factor	DOE Program Activities
	Oil	Gas					
DOE plus Industry; Baseline. • The discharge of produced water from offshore facilities is allowed per current offshore effluent limitations.	**$0**	**$0**	Capital & Annual	New & Existing Offshore Wells	1996 to 2005	**0.40**	• Advocate & support risk-based regulatory analysis and decision-making process. • Comment on rule-makings as appropriate. • Support research on offshore produced water testing and management technology such as development of improved produced water toxicity testing. • Support research on offshore waste management technologies including economic and energy impact analysis. • Comment on coastal effluent limitation rulemaking. (Final Rule Effluent Limitation Guidelines and Standards for the Coastal Subcategory on Dec.16, 1996). • * 1986 - Comments three or four different studies • Toxicity Testing Technology. • Data collection & facilitate dialog • Continental Shelf Associates study on discharge in Gulf of Mexico
Stringent Case. • Zero discharge of produced water is required for all new and existing facilities beyond three miles from shore.	**$288,000**	**$288,000**	Capital	New Offshore Wells			
	$21,000	**$21,000**	Annual	New Wells			
	$264,000	**$264,000**	Capital	Existing Offshore Wells	1996 to 2005		
	$22,000	**$22,000**	Annual	Existing Wells			

10. PRODUCED WATER MANAGEMENT: Water Treatment (Compliance Technology R&D)							
Scenarios	Estimated Incremental Environmental Compliance Cost		Type of Cost	Applied to	Years	DOE Program Impact Factor	DOE Program Activities
	Oil	Gas					
DOE plus Industry; Baseline. • Regional application of various water treatment technologies to prior to surface discharge or beneficial use of produced water • Ongoing research and technology transfer of alternative produced water management and treatment technologies such as downhole chemical treatment, media filtration and biotreatment.	**$0**	**$0**	Annual	New and Existing	1996 to 2002	**0.20**	• Support research and facilitate technology transfer for new cost-effective technologies such as freeze-thaw water treatment and constructed wetlands for water treatment. • Support academic and industry research on water treatment technology including Penn State water treatment project, ARCO potable water project in CA. • Argonne National Laboratory analysis of costs of alternative water treatment technologies., ANL cost analyses.
Limited Technology R&D Case. • Without cost effective water treatment technologies, the cost of produced water disposal would be higher in regions that are geologically unfavorable for disposal of produced water by underground injection..	Appalachian States: **$20,400** Rocky Mtn. Region and California: **$2,760**	Appalachian States: **$770** Rocky Mtn. Region and California: **$100**	Annual Annual	New & Existing Wells; Apply full cost to 2% of wells	1996 to 2002		

11. PRODUCTION WASTE MANAGEMENT: Associated Waste Management (Regulatory Issue)

Scenarios	Estimated Incremental Environmental Compliance Cost		Type of Cost	Applied to	Years	DOE Program Impact Factor	DOE Program Activities
	Oil	Gas					
DOE plus Industry; Baseline. • Currently 38 percent of liquid associated wastes are disposed by injection. • * Fifteen percent of all associated wastes are disposed in commercial E&P waste disposal facilities.	**$0**	**$0**	Annual	New and Existing Wells	1996 to 2004	**0.40**	• Advocate & support risk-based regulatory analysis and decision-making process at state and Federal level • IOGCC: waste minimization guidelines and "STRONGER" (State Review of Oil and Gas Environmental Regulation). • Comment on rule-makings as appropriate. • Cooperative efforts with states, EPA and industry. • Technical workshops, conferences (IOGCC) • Interagency workshop for rulemaking: 1988/89 • State Review Process • DRI Study • 17 State Study • Cumulative Impacts Study • Grand Bois air monitoring and research
Stringent Case. • Loss of RCRA Exemption for E&P wastes including associated wastes • All on site disposal and off site land - based disposal is prohibited. • All associated wastes not currently disposed by injection or disposed at commercial facilities must be disposed at offsite commercial E&P waste disposal facilities. • All associated wastes tested prior to disposal. Wastes testing hazardous are disposed at hazardous waste disposal facilities.	**$390**	**$390**	Annual	New and Existing Wells	1996 to 2004		

12. PRODUCTION WASTE MANAGEMENT: NORM Management and Waste Disposal (Regulatory Issue)

Scenarios	Estimated Incremental Environmental Compliance Cost		Type of Cost	Applied to	Years	DOE Program Impact Factor	DOE Program Activities
	Oil	Gas					
DOE plus Industry; Baseline. • NORM waste disposal is regulated at the state level. • State regulations define NORM activity limit as either 5 pCi/gm or 30 pCi/gm above background. • No current backlog of NORM waste. Most oilfield NORM is either disposed at the New Park facility in Big Hill, TX ,or encapsulated in abandoned wells. • Advanced Sampling and Analysis Protocol reduces potential volume of NORM contaminated soil for remediation/disposal.	**\$0**	**\$0**	Capital and Annual	New & Existing Wells (apply only in states w/ oilfield NORM: TX, LA, AL, AR, MI, NY, OK, OH, NM	1996 to 2003	**0.40**	• Advocate & support risk-based regulatory analysis and decision-making process. • Support research to related to characterize levels of risk. Risk assessment of alternative disposal methods. • IOGCC model state regulation for NORM; state review process. • Interagency NORM Subcommittee. • Oilfield NORM Web site and Bibliography • Support research for optimal site characterization & cost effective on site remediation technologies. • Research for alternative NORM disposal: salt cavern disposal, land spreading.
Stringent Case. • NORM regulated at the Federal level. All NORM defined at the 5 pCi/g activity cut-off. • All NORM disposed at commercial NORM disposal facility or low-level radioactive waste disposal facility. • NORM disposal costs and transportation costs remain high due to lack of disposal options.	**\$2,100** **\$308**	**\$1,900** **\$308**	Capital Annual	Existing New & Existing Wells (in states as above)	 1996 to 2003		

13. PRODUCTION WASTE MANAGEMENT: Salt Cavern Disposal of E&P Waste (Compliance Technology R&D)

Scenarios	Estimated Incremental Environmental Compliance Cost		Type of Cost	Applied to	Years	DOE Program Impact Factor	DOE Program Activities
	Oil	Gas					
DOE plus Industry; Baseline. • Salt caverns have been developed for the disposal of oily E&P wastes in West Texas. • Salt cavern disposal began in 1997 and is expanding as more disposal caverns are developed. • TX recently issued regulations for disposal of wastes in salt caverns.	**$0**	**$0**	Annual	New Offshore Wells	1997 to 2005	**0.40**	• Advocate & support risk-based regulatory analysis and decision-making. • Support internet-based information and technology transfer. • Funded salt cavern studies: technical and legal feasibility; engineering and site studies; cost and economic analyses, risk analysis for disposal of NORM and other hazardous wastes in salt caverns. • Briefings for state regulators.
Limited Technology R&D Case. • If no salt cavern disposal option is available in Texas, higher E&P waste disposal costs are expected due to increased transport distances to commercial E&P waste disposal facilities, or costly on site treatment for oil contaminated wastes.	**$5,000**	**$0**	Annual	New & Existing oil wells. (Apply full cost to 15% of TX wells)	1997 to 2005		

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14. PRODUCTION WASTE MANAGEMENT: Offshore and Coastal Sediment Monitoring and Remediation (Regulatory Issue)

Scenarios	Estimated Incremental Environmental Compliance Cost		Type of Cost	Applied to	Years	DOE Program Impact Factor	DOE Program Activities
	Oil	Gas					
DOE plus Industry; Baseline. • April 1998, EPA issued a coordinated plan for reducing risks posed by contaminated sediment: Contaminated Sediment Management Strategy. Primarily addresses onshore and coastal sediment contamination. However, no current sediment monitoring requirements. • For offshore oil and gas operations, the sediment monitoring issue is assumed to apply only to discharge of produced water and other production waste. • In Gulf of Mexico, MMS requires some sediment monitoring for data gathering/ research.	**$0**	**$0**	Capital	Existing	1996 to 1998	**0.10**	• Comments on EPA's contaminated sediment management strategy. • Promote risk-based regulatory analysis and decision-making. • Gulf of Mexico study showing recovery of coastal areas.
Stringent Case. • Sampling and testing required at 25 percent of coastal production facilities	**$2,400**	**$2,400**	Capital	Apply to existing coastal and offshore wells in LA and TX	1996 to 1998		

15. REMEDIATION: Remediation of Hydrocarbon Contamination (Regulatory Issue)							
Scenarios	Estimated Incremental Environmental Compliance Cost		Type of Cost	Applied to	Years	DOE Program Impact Factor	DOE Program Activities
	Oil	Gas					
DOE plus Industry; Baseline. • State regulations currently guide site cleanups when property is sold, transferred, or sites are abandoned. • Some states have voluntary remediation programs; others states require mandatory contributions to fund clean up of abandoned oil and gas production sites. • Soil remediation and site restoration is reduced from 50 to 25 percent of gas plants, oil production facilities, and gas dehydration sites.	**$0**	**$0**	Capital	Existing	1996 to 2002	**0.25**	• Work with states to advocate & support risk-based regulatory analysis and decision-making process. • Support research related to characterizing levels of risk. • Support research on optimal methods for site characterization and cost-effective clean up technologies. • Support joint research with PERF • California pipeline study • Oil spill reporting study • Ohio bioremediation study • Refining related bioremediation research • Risk-based cleaning levels – PERF, • Tall Grass Prairie ecological impacts • OERB abandoned sites remediation initiative
Stringent Case. • Mandatory remediation of hydrocarbon contamination at production sites. Production sites requiring remediation estimated to range from 25 percent to 75 percent of potential sites.	**$310**	**$115**	Capital	Existing	1996 to 2001		

16. AIR EMISSIONS: Onshore Emissions Control, E&P MACT Rule (Regulatory Issue)

Scenarios	Estimated Incremental Environmental Compliance Cost		Type of Cost	Applied to	Years	DOE Program Impact Factor	DOE Program Activities
	Oil	Gas					
DOE plus Industry; Baseline. • National Emissions Standards for Hazardous Air Pollutants (NESHAPS) for oil and natural gas production facilities issued June 1999. • Requires BACT on major source: glycol dehydration units, condensate tank batteries, and gas plants. • Requires leak detection and repair program.	**$0**	**$0**	Capital & Annual	New & Existing Wells	1996 to 2001	**0.25**	• Interagency collaboration • Advocate & support risk-based regulatory analysis and decision-making. • Comments on NESHAPS rulemaking • DOE/API compliance workshop for independent operators • Develop air model to characterize risk • Research on VOC recovery from tanks pursuant to CA EPA task force recommendations.
Stringent Case. • Emissions controls on major and area sources adopted as originally proposed by EPA. Emissions controls required on black oil tanks. Risk-based criteria not applied to the definition of an area source.	**$705** **$60**	**$1,705** **$365**	Capital Annual	New & Existing Wells	1996 to 2001		

17. AIR EMISSIONS: Offshore Air Emission Control (Regulatory Issue)

Scenarios	Estimated Incremental Environmental Compliance Cost		Type of Cost	Applied to	Years	DOE Program Impact Factor	DOE Program Activities
	Oil	Gas					
DOE plus Industry; Baseline. • MMS maintains jurisdiction over air quality in the Gulf of Mexico Central and Western Planning Areas.	**$0**	**$0**	Capital and Annual	New and Existing Offshore Wells	1996 to 2002	**0.20**	• Advocate & support risk-based regulatory analysis and decision-making. • MMS/DOE project: contributions of offshore emissions to onshore air quality. • Economic impact assessments. • FACA committee participation during rulemaking • Substantial work early in CA and GOM. • Breton Wilderness Area air monitoring project
Stringent Case. • All production facilities in the Central and Western Planning Areas of the Gulf of Mexico are under EPA jurisdiction. • Air emissions from sources within 25 miles of states' seaward boundaries are subject to the same regulatory requirements as sources in the nearest onshore area. • Best Achievable Control Technology requirements and NESHAPs for oil and natural gas production facilities are applied to all production facilities in the Gulf of Mexico, including facilities beyond 25 miles of state territorial seas.	**$23,700** **$15,800** **$16,200**	**$23,700** **$15,800** **$16,200**	Capital Capital Annual	Existing Offshore Wells New Offshore Wells New and Existing Offshore Wells	1996 to 2002		

18. AIR EMISSIONS: Compliance Assurance (Enhanced) Air Monitoring (Regulatory Issue)

Scenarios	Estimated Incremental Environmental Compliance Cost		Type of Cost	Applied to	Years	DOE Program Impact Factor	DOE Program Activities
	Oil	Gas					
DOE plus Industry; Baseline. • Final Compliance Air Monitoring rule issued in Oct 1997, effective Nov. 1997.	**$0**	**$0**	Capital and Annual	New and Existing	1996	**0.05**	• Advocate risk-based regulatory analysis and decision-making throughout rulemaking process.
Stringent Case. • Continuous enhanced air monitoring for compliance assurance is required at all gas plants and major source glycol units and major source oil and condensate tank batteries.	**$280** **$180**	**$1,600** **$570**	Capital Annual	New and Existing Wells	1996		

19. AIR EMISSIONS: Risk Management Programs (Regulatory Issue)

Scenarios	Estimated Incremental Environmental Compliance Cost		Type of Cost	Applied to	Years	DOE Program Impact Factor	DOE Program Activities
	Oil	Gas					
DOE plus Industry; Baseline. • Final rule issued June 1996 requires development and implementation of a risk management program (RMPs) at facilities that produce, process, handle, or store regulated toxic or hazardous substances at greater than threshold quantities. • Risk Management Programs required at gas plants.	**$0**	**$0**	Capital	New and Existing Wells	1996	**0.25**	• Advocacy for risk-based regulatory analysis and decision-making. • Comments on rulemaking. • Support development of generic RMPs and Best Management Practices. • Compliance workshops for plant operators. towards aiding industry compliance.
Stringent Case. • Risk management programs, (RMPs) are required at all gas plants and production facilities.	**$6,600**	**$6,600**	Capital	New and Existing Wells	1996		

20. AIR EMISSIONS: Title V Operating Permits (Regulatory Issue)

Scenarios	Estimated Incremental Environmental Compliance Cost		Type of Cost	Applied to	Years	DOE Program Impact Factor	DOE Program Activities
	Oil	Gas					
DOE plus Industry; Baseline. • States required to implement Title V operating permit programs. • Operating permits required for all gas plants, major source glycol units, and major source oil and condensate tank batteries.	**$0**	**$0**	Capital and Annual	New and Existing Wells	1996 to 1997	**0.10**	• Regulatory advocacy, comments on rulemaking • (Benefits gained from reduction in HAP emissions through Best Management Practices are already captured under the 'Onshore Emissions Control/ E&P MACT' issue. • (Benefit from guidance to states for general permits, etc. already captured under 'Regulatory Streamlining' issue).
Stringent Case. • Various stringent regulatory scenarios assumed higher emission fees, lower emissions rates, and inclusion of area sources.	**$150** **$30**	**$440** **$230**	Capital Annual	New and Existing Wells	1996 to 1997		

21. UNDERGROUND INJECTION: Regulation of Hydraulic Fracturing as Underground Injection (Regulatory Issue)							
Scenarios	Estimated Incremental Environmental Compliance Cost		Type of Cost	Applied to	Years	DOE Program Impact Factor	DOE Program Activities
	Oil	Gas					
DOE plus Industry; Baseline. • Regulation of hydraulic fracturing as underground injection in 1999. Limited to coal bed methane wells in Alabama.	**$0**	**$0**	Capital	New Gas Wells; hydraulically fractured	1999 to 2002	**0.0**	• Advocate & support risk-based regulatory analysis and decision-making. • NEC comments, issue raised by oil task force. • Provide support for analysis of potential economic impact to states & 1998 GWPC survey of coal bed methane operations. • Support legislative exemption for hydraulic fracturing.
Stringent Case. • The regulation of hydraulic fracturing as underground injection applies to all hydraulically fractured wells nationwide.		**$67,300**	Capital	All new hydraulically fractured gas wells; (includes tight gas, coalbed methane, fractured shale)	1999 to 2002		

22. UNDERGROUND INJECTION: Area of Review, Existing Wells (Regulatory Issue)							
Scenarios	**Estimated Incremental Environmental Compliance Cost**		**Type of Cost**	**Applied to**	**Years**	**DOE Program Impact Factor**	**DOE Program Activities**
	Oil	**Gas**					
DOE plus Industry; Baseline. • Injection wells permitted by rule (pre-1984) do not require AOR.	**$0**	**$0**	Capital	Existing Wells	1996	**0.30**	• Participation on FAC for revising UIC regulations. • Substantial support for development, demonstration and application of variance methodology. • Basin Risk Study • Support University of Missouri-Rolla analysis of issue • Assistance to states with risk based data management system. • Support Ground Water Protection Council AOR variance committee
Stringent Case. • All underground injection wells previously permitted by rule are required to have an AOR study. Some percentage of existing injection wells require corrective action.	**$396**	**$396**	Capital	Existing Wells	1996		

23. UNDERGROUND INJECTION: Area of Review, New Wells (Compliance Technology R&D)							
Scenarios	Estimated Incremental Environmental Compliance Cost		Type of Cost	Applied to	Years	DOE Program Impact Factor	DOE Program Activities
	Oil	Gas					
DOE plus Industry; Baseline. • Variances for newly drilled injection wells granted in East Texas Field. • AOR variance program under consideration in OK, KS	$0	$0	Capital	New Wells in TX	1996 to 2005	0.75	• Advocate & support risk-based regulatory analysis and decision-making process. • Support development of risk-based data management system (RBDMS). • Support pilot programs to identify wells for corrective action. • Assistance to states with RBDM, and AOR variance development. • Participation on FAC for revising UIC regulations. • Variance studies (East Texas field and elsewhere). • Support development, demonstration and application of variance methodology
Limited Technology R&D Case. • No fields receive variances from AOR requirements	$320	$174	Capital	New Wells in TX	1996 to 2005		

24. UNDERGROUND INJECTION: USDW Protection and Injection Well Construction (Regulatory Issue)							
Scenarios	Estimated Incremental Environmental Compliance Cost		Type of Cost	Applied to	Years	DOE Program Impact Factor	DOE Program Activities
	Oil	Gas					
DOE plus Industry; Baseline. • Most states have primacy for UIC programs and require conventional well construction (3 layers of protection) to protect aquifers w/ TDS < 3,000 mg/l. • All states require some protection for USDWs with TDS <10,000 mg/l.	**$0**	**$0**	Capital	Existing Wells New Wells	1996 to 2005	**0.30**	• Assistance to states with Risk Based Data Management System (RBSMS) • Advocate & support risk-based regulatory analysis and decision-making. • Participation on Federal Advisory Committee for revising UIC regulations • Support relevant economic impact analyses, technical analyses & variance studies. • Support to States through GWPC/UIPC.
Stringent Case. • All new injection wells must protect USDWs w/ TDS <10,000 mg/l with 3 layers of protection (conventional well construction).	**$500** **$1,780**	**$500** **$1,780**	Capital Capital	Existing Wells New Wells	1996 to 2005		

25. UNDERGROUND INJECTION: Mechanical Integrity Testing (Regulatory Issue)							
Scenarios	Estimated Incremental Environmental Compliance Cost		Type of Cost	Applied to	Years	DOE Program Impact Factor	DOE Program Activities
	Oil	Gas					
DOE plus Industry; Baseline. • Mechanical integrity tests performed at least once every five years. • Each state determines the appropriate mechanical integrity test and test frequency. State regulation must meet or exceed federal standards.	**$0**	**$0**	Annual	Existing	1996 to 2005	**0.30**	• Advocate & support risk-based regulatory analysis and decision-making. • Risk based data management system (RBDMS). • Participation on Federal Advisory Committee (FAC) for revising UIC regulations. • Economic impact analysis. • Guidance documents • Support to States through GWPC/UIPC
Stringent Case. • Recommendations of the FAC for revision of underground injection control regulations. Recommendations have not been implemented on Federal level & MIT continues to be regulated by the states. Recommended MIT frequency: - Once every 5 years: 3 layers of protection (LP) and long surface casing (LSC). - Once every 3 years: 3 LP and short surface casing (SSC) or 2 LP and LSC. - Once every year: 2 LP and SSC	**$40**	**---**	Annual	Existing Wells (Apply full cost to 70% of wells)	1996 to 2005		

26. SPILLS AND OTHER ISSUES: SPCC Plan (Regulatory Issue)							
Scenarios	Estimated Incremental Environmental Compliance Cost		Type of Cost	Applied to	Years	DOE Program Impact Factor	DOE Program Activities
	Oil	Gas					
DOE plus Industry; Baseline. • All owners or operators of SPCC-regulated facilities should determine whether the facility poses a threat of substantial harm to the environment. • SPCC plans are required and must be reviewed every three years.	$0	$0	Capital Annual	New and Existing Wells	1996 to 2001	**0.15**	• Advocate & support risk-based regulatory analysis and decision-making. • Comments on rulemaking • Interagency collaboration * Support cost-effective compliance solutions for small operators. • California oil spill and pipeline reporting studies
Stringent Case. • SPCC plans are required for nearly all production facilities,. Assumes fifty percent of new and existing oil wells are within ¼ mile of navigable water and are required to have SPCC plan.	**$825** **$200**	$0	Capital Annual	New and Existing Wells (Apply full costs to 50% of wells)	1996 to 2001		

27. SPILLS AND OTHER ISSUES: Aboveground Storage Tank Leak Protection (Regulatory Issue)							
Scenarios	Estimated Incremental Environmental Compliance Cost		Type of Cost	Applied to	Years	DOE Program Impact Factor	DOE Program Activities
	Oil	Gas					
DOE plus Industry; Baseline. • Current regulations require ASTs to be designed and constructed in accordance with standard industry practice. • Retrofit of existing tanks is not generally required unless tank is undergoing some other maintenance. • Other leak containment barriers are required even if AST is not retrofit with release prevention barriers.	**$0**	**$0**	Capital	Existing	1996 to 1997	**0.10**	• Advocate risk-based regulatory analysis and decision-making. • Comment on rulemaking as appropriate.
Stringent Case. • All existing and new tanks at E&P facilities larger than 500 gallons require retrofit with release prevention barriers (RPBs). • Assumes that 15 percent of existing tanks at E&P facilities are already retrofit with RPBs.	**$3,950**	**$1,700**	Capital	Existing Wells	1996 to 1997		

28. SPILLS AND OTHER ISSUES: Certificate of Financial Responsibility (Regulatory Issue)

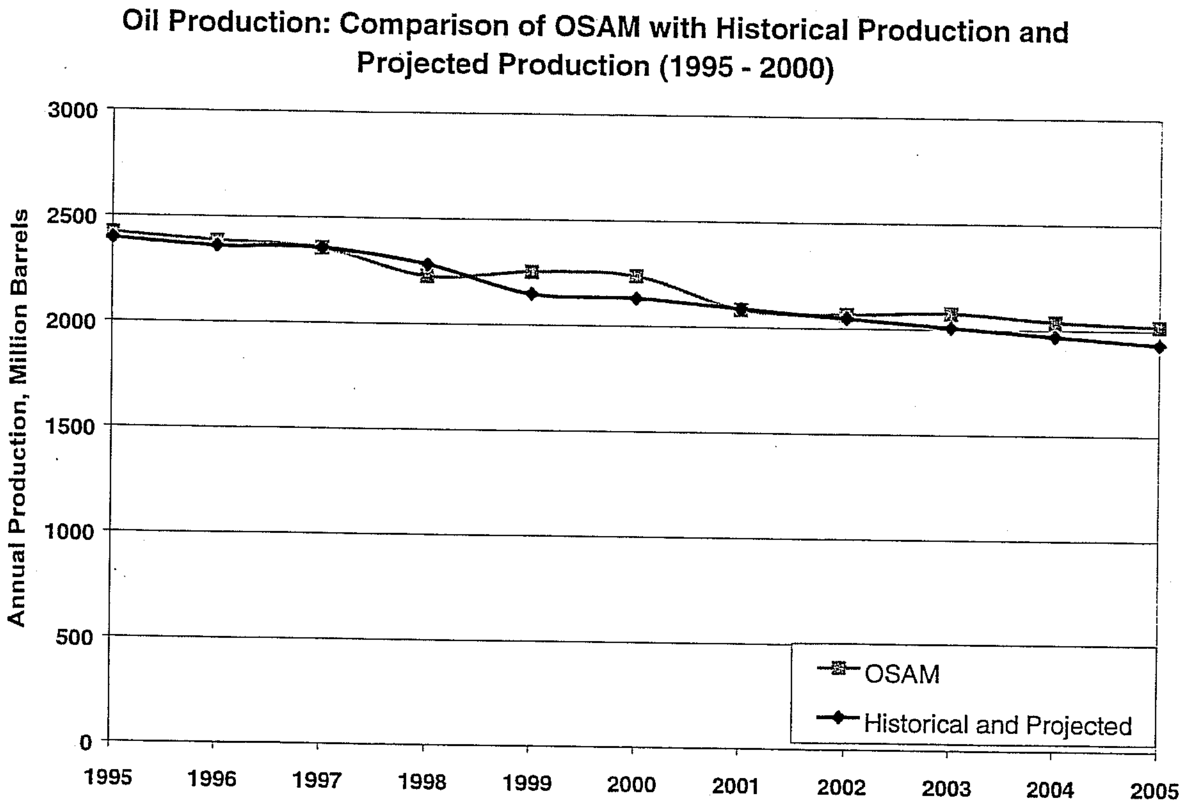
Scenarios	Estimated Incremental Environmental Compliance Cost		Type of Cost	Applied to	Years	DOE Program Impact Factor	DOE Program Activities
	Oil	Gas					
DOE plus Industry; Baseline. • Final rule requiring demonstration of spill financial responsibility issued August 1998. • Operators in OCS have financial responsibility ranging from $35 - $150 million depending upon worst-case spill potential. • Operators in state waters provide COFRs for $10- $35 million. • Facilities with a worst case spill potential of <1000 barrels are exempt. • Most operators either self-insure or pay an annual insurance premium.	**$0**	**$0**	Capital	New and existing offshore oil wells	1996 to 1998	**0.20**	• Comments on rulemaking to EPA & Coast Guard in support of insurance levels commensurate with risk-based analysis. • NPC study of OPA costs/impacts. • Support stakeholder working group
Stringent Case. • All operators in OCS must carry certificate of financial responsibility for $150 million.	**$50,500**	**$0**	Capital	New and existing offshore oil wells	1996 to 1998		

29. SPILLS AND OTHER ISSUES: Toxic Release Inventory, TRI (Regulatory Issue)							
	Estimated Incremental Environmental Compliance Cost						
Scenarios	**Oil**	**Gas**	**Type of Cost**	**Applied to**	**Years**	**DOE Program Impact Factor**	**DOE Program Activities**
DOE plus Industry; Baseline. • Proposed rule requiring TRI reporting is delayed indefinitely.	**$0**	**$0**	Capital and Annual	New and Existing	1996 to 2002	**0.50**	• TRI Economic Impact Analysis • Advocate & support risk-based regulatory analysis and decision-making. • Interagency comments/discussion • Comments on rule-makings. • * Pilot Program to demonstrate state-based TRI reporting in OH and OK • Project for IOGCC • Joint funded study with API • Funded TRI FAC for state regulators and industry • TRI field trips for stakeholders
Stringent Case. • TRI reporting requirements are met under an EPA program rather than state-based reporting programs. • TRI reporting required for offshore operations in Federal OCS.	**$200** **$100**	**$100** **$45**	Capital Annual	New & Existing Existing	1996 to 2002		

30. SPILLS AND OTHER ISSUES: NPDES Storm Water Permitting (Regulatory Issue)							
Scenarios	Estimated Incremental Environmental Compliance Cost		Type of Cost	Applied to	Years	DOE Program Impact Factor	DOE Program Activities
	Oil	Gas					
DOE plus Industry; Baseline. • Drilling operations required to have NPDES storm water discharge permits as well as erosion control and storm water containment measures. • Compliance costs reduced through technology transfer of Best Management Practices, cost-effective solutions for small operators' compliance training.	$0	$0	Capital	New and Existing Wells	1996 to 2000	0.30	• Advocate & support risk-based regulatory analysis and decision-making. • Comment on rule-makings as appropriate. • Support cost-effective compliance solutions for small operators. • Compliance training, and best management practices.
Stringent Case. • Compliance costs could be as much as 50% higher.	$890 $420	$890 $420	Capital Capital	New (Apply full cost to 50% of wells) Existing (Apply full cost to 50% of wells)	1996 to 2000		

31. SPILLS AND OTHER ISSUES: Regulatory Streamlining (Regulatory Issue)							
Scenarios	Estimated Incremental Environmental Compliance Cost		Type of Cost	Applied to	Years	DOE Program Impact Factor	DOE Program Activities
	Oil	Gas					
DOE plus Industry; Baseline. • Oil and gas operating costs are reduced and operations are streamlined due to various streamlining measures.	**$0**	**$0**	Annual	New and Existing Wells	1996 to 2000	**0.20**	• Advocate & support risk-based regulatory analysis and decision-making. • Develop cost-effective best management practices and regulatory streamlining. • Interagency contribution • Environmental Compliance Advisory System. • RBDMS • NORM Training • Remediation Training • NPDES Training • Federal Lands Project • Paperwork reduction
Stringent Case. • Operating costs estimated to be 0.5% higher without regulatory streamlining	**$765**	**$825**	Annual	New and Existing Wells	1996 to 2000		

APPENDIX C. OIL AND GAS MODELS PRODUCTION MATCH



Gas Production: Comparison of GSAM with Historical and Projected Production (1995 - 2005)